THE ADJUSTMENT OF STOCK PRICES TO NEW INFORMATION: A TEST OF MARKET EFFICIENCY

By

STEWART L. BROWN

A DISSERTATION PRESENTED TO THE GRADUATE COUNCIL OF
THE UNIVERSITY OF FLORIDA
IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE
DEGREE OF DOCTOR OF PHILOSOPHY

UNIVERSITY OF FLORIDA

1974

ACKNOWLEDGMENTS

The author would like to thank Dr. C. A. Matthews for moral and financial support while at the University of Florida. The author is indebted to Dr. Fred Arditti, Chairman of the Committee, for many helpful comments and suggestions and the rest of the Committee: Drs. John McFerrin, W. A. McCollough, Christopher Barry, and James McClave for moral support and helpful suggestions. All deficiencies and mistakes are, of course, the sole responsibility of the author.

TABLE OF CONTENTS

Abstract of Dissertation Presented to the
Graduate Council of the University of Florida in
Partial Fulfillment of the Requirements
for the Degree of Doctor of Philosophy

THE ADJUSTMENT OF STOCK PRICES TO NEW INFORMATION:
A TEST OF MARKET EFFICIENCY

By

Stewart L. Brown

December, 1974

Chairman: Fred D. Arditti
Department: Finance and Real Estate

The issue of capital market efficiency with respect to publicly available information has not been resolved. Studies examining the adjustment of stock prices to new Earnings Per Share information yield conflicting results. It seems that stock prices do not adjust instantaneously although the adjustment process has not been examined in detail. There is, however, a question as to whether or not it is possible to earn an abnormal rate of return by trading on the basis of publicly available information. The purpose of this dissertation is to examine the adjustment of the stock market to unexpected changes in EPS and to determine if an abnormal rate of return could have been earned.

Cumulative average stock price return residuals from the market model are examined on a daily basis for twenty market days before and through sixty market days after publication of annual EPS numbers in The Wall Street Journal. The market model is used to abstract stock returns from risk and general market movements. Both unexpectedly high and unexpectedly low EPS numbers are examined for a sample of 158 firms listed on the New York or American Stock Exchanges. All firms in the sample have at least a 20 percent change in annual EPS and fourth quarter results different from what could have been predicted on the basis of the first three quarters of EPS. A first order autoregressive scheme is fit to the cumulative average residual and is useful in obtaining an estimate of the confidence interval around the predicted cumulative rate of return of the securities in the sample.

Statistically significant returns are observed around the publication date of the EPS number in The Wall Street Journal. The lower confidence limit of the predicted cumulative return is above estimated transactions costs for both long purchases of securities with unexpectedly high EPS and short sales of the securities with unexpectedly low EPS.

The adjustment process takes about forty-five market days after the EPS publication date. The pattern

of adjustment is similar for both unexpectedly high and unexpectedly low EPS. There appears to be three distinct stages in the adjustment process: an initial price trend directly related to the direction of change in EPS; a second trend inversely related to the change in EPS; and a third trend directly related to the change in EPS, lasting from about day 10 to about day 45 after the earnings announcement. The price change in the third stage appears to be permanent. It is speculated that the pattern of adjustment is caused by a lag between publication of the EPS number in The Wall Street Journal and availability of the more complete information in the Annual Report.

It is concluded that the stock market was not efficient with respect to the securities in the sample, since an abnormal return in excess of transactions costs could have been earned by purchasing the securities on the publication date of the EPS number. The implication is that the stock market may, in general, be less efficient than has been heretofore believed.

CHAPTER I

INTRODUCTION

Purpose of the Study

The purpose of this paper is to test whether or not it is possible, in a statistical sense, to earn a rate of return in excess of the normal rate of return in the stock market by purchasing securities whose earnings per share (EPS) are greater than expected as soon as such information becomes publicly available. A subsidiary purpose is to examine the pattern and speed with which the stock market adjusts the prices of securities to reflect new EPS information.

This study is concerned with the means by which information about investments is disseminated to and used by investors. The concern with the effects if information on capital asset prices places this study in the realm of what has come to be called the "Efficient Markets Hypothesis" (EMH). This hypothesis, which would be better labeled the "Efficient Capital Markets Hypothesis," has no generally accepted formal definition other than the rather vague and basic notion that an efficient market is one that fully reflects all available information. Sharpe [33] presents a concise definition:

> Simply put, the thesis is this: in a well-functioning market, the prices of capital assets (securities) will reflect predictions based on all relevant and available information.

An implication of market efficiency is that it is difficult to earn a rate of return in excess of the normal rate of return. If the stock market reflects (has discounted) all information, then an investment strategy which is based on some form of information relevant to share prices, says EPS information, will fail to produce an abnormal rate of return because such information will already have been discounted in security prices.

The Efficient Markets Hypothesis is an application of the theory of perfect capital markets which, in turn, is derived from the economic theory of price formation under pure competition. The assumptions concerning the effects of information on share price is aptly pointed out by a concise definition of a perfect capital market [27]:

> In a "perfect capital market," no buyer or seller (or issuer) of securities is large enough for his transaction to have an appreciable impact on the then ruling price. All traders have equal and costless access to information about the ruling price and about all other relevant characteristics of shares. No brokerage fees, transfer taxes, or other transactions costs are incurred when securities are bought, sold, or issued, and there are no tax differentials . . . .

Thus, in a perfect capital market, with an absence of frictions and a perfect information system, the prices of capital assets are always the "correct" prices in the

sense that they always fully reflect all relevant information. Those who believe in the EMH contend that the conditions in actual capital markets are sufficiently similar to the requirements of a perfect capital market that actual security prices may be thought of as the "correct" prices; i.e., they fully reflect all available information.

One difference between a perfect capital market and an efficient market is that an efficient capital market may be efficient with respect to some kinds of information and not efficient with respect to other kinds. Fama [14] has established a hierarchy of information types to delineate different degrees of market efficiency.

At its lowest level the stock market is deemed efficient if it reflects historical information. The stock market has been found to be quite efficient with respect to this type of information. Empirical tests at this level, labeled "weak-form" tests of the EMH by Fama, include tests of the familiar random walk hypothesis (see Cootner [11]).

At the second level, the market is deemed efficient if it reflects all publicly available information. Since publicly available information is also historical information, tests at this level of efficiency are typically concerned with the speed at which the stock market adjusts to new information. Empirical tests at this level have been labeled "semi-strong form" tests of the EMH. The

hypothesis has received mixed support at this level, but the market has generally been found to be quite efficient (see Fama [14] and Downes and Dyckman [12]).

At its highest level, the stock market is deemed efficient if it reflects all information, including information not publicly available. Empirical tests at this level are concerned with whether or not some groups of investors have monopolistic access to sources of information which allows them to reap excess returns. Tests at this level are labeled "strong form" tests of the EMH. There have been few such tests at this level, but those which have been conducted have found some market inefficiencies (see Jaffe [18], Niederhoffer and Osboirne [29], and Jensen [19]).

Market Efficiency with Respect to EPS Information; The Evidence

There are two major studies which examine market efficiency with respect to EPS information. One study, by Ball and Brown [3], purports to show that the market is efficient with respect to this type of information; i.e., it is impossible to make money by using EPS information as it becomes publicly available. The other study, by Jones and Litzenberger [20], purports to show that the market is inefficient; i.e., it is possible to earn an abnormal return by trading on publicly available information.

Thus, the two studies arrived at opposite conclusions about market efficiency with respect to EPS information. Each of the two studies will be examined in detail, and some reasons they arrived at different conclusions will be explained and discussed. First, however, some general assumptions and methodological considerations must be discussed so as to establish an analytical framework needed to examine the articles.

Assumptions and Methodology

An implicit assumption of studies which examine market efficiency with respect to EPS information is that there is a direct relationship between the level of a firm's EPS and its share price (assuming all other things are equal, like risk); i.e., the higher the level of EPS, the higher the firm's share price and vice versa. Empirical studies have found that this assumption is warranted (see Malkial [25]).

This relationship between EPS and share price allows researchers to test market efficiency with respect to EPS information. The basic method involves identifying a large sample of securities with changes in EPS and then looking at the average price change or rate of return from purchasing those securities after the arrival of the EPS information. This average price change is typically computed after abstracting from risk and general market

conditions (the method of abstracting from risk will be detailed in the next chapter). If it is possible to earn an excess rate of return from purchasing the securities, then the market is said to be inefficient. This rate of return is sometimes compared to transactions costs as a further test of efficiency.

The method of identifying changes in EPS and, hence, of determining the securities to be included in the sample is crucial to the analysis of the subsequent average price change observed. Different studies use different EPS models, but all have some implicit underlying assumptions. Prior to the public availability of the actual EPS number, there is assumed to exist in the market some expectation of the EPS number. This expectation of EPS _is not observable but is the consensus of investors' estimates of the forthcoming EPS_. This consensus is reflected in the price of the security just prior to the arrival of the actual number. The change in price after the arrival of the actual number is assumed to be directly related to the difference between expected and actual EPS numbers. If the actual number is greater than the expected number, then it is assumed that the share price will rise, and vice versa. Another assumption is that, _ceteis paribus_, the greater the difference between actual and expected EPS, the greater will be the resultant price change.

Given the above assumptions and discussion, the Forecast Error (FE) may be defined as the difference between the actual EPS number (EPS_t) in time period $\underline{t}$ and the expected EPS in time $\underline{t}$, $E(EPS_t)$, i.e.

$$FE = EPS_t - E(EPS_t). \tag{1}$$

The expected EPS is never known with certainty but must be estimated. Different studies use different models to estimate it. This estimate of expected EPS in $\underline{t}$ will be labeled $\hat{E}(EPS_t)$, whatever model is used. The estimated forecast error, $\hat{FE}$, may then be defined as

$$\hat{FE} = EPS_t - \hat{E}(EPS_t). \tag{2}$$

It can be seen that the average price change of the securities in a sample after the arrival of some new EPS information will be influenced strongly by the method used to estimate $E(EPS_t)$, since this will directly influence which securities are included in the sample. The greater the difference between the actual (but unknown) $E(EPS_t)$ and the $\hat{E}(EPS_t)$ estimated by some model, the smaller will be the likelihood that the average price change observed will be representative of the true market reaction. It will be useful to keep the above discussion in mind as it will bear directly on the methodology of the studies to be discussed next.

<u>The Ball and Brown Study</u>

For their main results Ball and Brown used a regression model to estimate the expected annual EPS of a

sample of securities. This model attempted to take advantage of the facts that the EPS of firms are typically correlated with one another and that the market may use this information in forecasting EPS numbers. The procedure was to regress the change in annual EPS of their sample of firms on the change in an index of EPS for all firms. This regression relationship and the change in the index in a year of interest were used to estimate the change in annual EPS of the firms in the sample.

The estimated change in EPS for each firm was then used to estimate the expected EPS which was compared to the actual EPS number. If the actual number were greater than the estimated number, then the firm's earnings were classified as having "increased," and if the actual number were less than the estimated number, then the firm's earnings were classified as having "decreased."

Once the securities in the Ball and Brown sample had been classified by the above procedure, their price behavior was examined. Ball and Brown constructed what they call an Abnormal Performance Index (API). It may be thought of as the average rate of return of the securities in the sample after abstracting from risk and general market conditions. They looked at the API for twelve months before and six months after the arrival of the new EPS information. The return was examined before the arrival

of the actual number in order to scrutinize the market's anticipation of EPS.

They found that the API rose throughout the year in advance of the announcement for the earnings "increased" category, and fell throughout the year for the earnings "decreased" category. They found that the drift upward and downward continued for perhaps as long as two months after the publication of the actual numbers.

Although the move in the API after the arrival of the annual report was significantly different from zero in a statistical sense, it was of a very small magnitude. The API reached about 8½ percent before the arrival of the actual numbers but increased only about 1 percent after the arrival. Ball and Brown concluded that it was impossible to earn an abnormal rate of return by purchasing the securities in their sample as soon as the annual EPS number became publicly available:

> Even if the relationship tended to persist beyond the announcement month, it is clear that unless transactions costs were within about 1 percent, there was no opportunity for abnormal profit once the income information had become generally available. Our results are thus consistent with other evidence that the market tends to react to data without bias, at least to within transactions costs.

These results are taken as evidence that the market accurately anticipated all earnings changes to the point that there was little or no market adjustment for the actual

information. It will be demonstrated that this conclusion may be in error.

The regression model used by Ball and Brown to classify a company's earnings as having "increased" or "decreased" implies the following decision rule: When the information becomes publicly available, purchase all those securities whose actual EPS number is greater than the estimated expected EPS and sell short all of those companies whose actual EPS number is less than those predicted by the regression model. Ball and Brown have demonstrated that the market is efficient on average to within transactions costs with respect to <u>this decision rule</u>. It does not demonstrate that abnormal returns cannot be earned by using other decision rules.

The methodology of the Ball and Brown study actually mitigates against finding a significant average increase in stock prices after the arrival of new EPS information. Suppose that the regression model predicts that a company will earn $1, and further suppose that this is an unbiased estimate of what the market thinks the company will earn. If the company actually earns $1.01, then according to the Ball and Brown method, this company will be <u>correctly</u> classified as having "increased" its earnings. However, since the market had closely realized its expectation it is unlikely that there would be much price adjustment as a

result of the confirmation of this expectation. Yet, this company's return would be included in each calculated average return and, in a sense, bias it downward after the receipt of the actual information. Thus, the Ball and Brown study may have consisted of many firms with little or no change in their prices and a few firms with a fairly large change in price. The resulting decision rule appears to be an unreasonable one.

A second, more serious problem is that the regression model may not be a good model for estimating the EPS which the market expects. Indeed, in an earlier study Ball and Brown [2] found that only about 40 percent of the variance in EPS of the securities in their sample was explained by an index of all companies' EPS. It may be that investors are able to utilize other sources of information to arrive at an estimate of EPS. Such sources may include quarterly or interim reports which are ignored in the Ball and Brown study. Thus, the actual expected EPS by the market may be quite different from the estimated expected EPS in the Ball and Brown regression model, which could have resulted in Ball and Brown classifying some securities as having "increased" earnings when, in fact, the market viewed these earnings as decreases. This would mean that their calculated average return for the two categories would include some securities whose actual price adjustment

was in an opposite direction to the expected price change. This could have biased their observed average returns and thus may have appeared to demonstrate a more efficient market than actually existed.

Another facet of the Ball and Brown study was that it used a monthly differencing interval for stock returns. The procedure was to note only the month in which an annual EPS number was reported and to ignore the actual date within the month that the report arrived. This had the effect of assuming that all reports arrived on the first day of the month. To the extent that this was not actually true, the approximate two-month adjustment period was shortened. While this may not have been serious, the monthly differencing interval for stock prices precluded a close examination of the adjustment process, although Ball and Brown noted that "The actual income number did not appear to cause any unusual jumps in the abnormal performance index in the announcement month."

One also has to have some doubts as to the generality of the Ball and Brown results with respect to the firms included in their sample, which were all large firms listed on the New York Stock Exchange. Since such firms tend to be well established, and their stocks are widely held, they probably receive close scrutiny from the market and the investment community. Smaller firms, perhaps OTC and AMEX firms, would be unlikely to have as

efficient an information system or to be as closely watched.

The Jones and Litzenberger Study

Jones and Litzenberger estimate expected quarterly EPS as the projected trend in historical quarterly EPS. The study hypothesizes "that quarterly earnings reports significantly greater than anticipated by market professionals from historical earnings trends would cause gradual price adjustments over time and generate intermediate stock price trends." Jones and Litzenberger use quarterly earnings reports and a selection criteria which implies the following decision rule: "Purchase those common stocks whose quarterly earnings exceed their projected quarterly earnings by at least 1.5 standard errors, and sell short those securities whose quarterly earnings fall short of the projected quarterly earnings by at least 1.5 standard errors." It can be seen that this model not only classifies earnings as increased or decreased, but also limits the sample to those companies with large increases or decreases in earnings.

Jones and Litzenberger observed the six-month price relative of the selected securities and compared this with the S&P 425 index price relative (rate of return). Six months was used because of the preferential capital gains tax treatment involved with this period. No interim prices were observed. They found that "the average price

relatives of the stocks selected in each period exceed the price relatives for the Standard and Poor's index in all ten of the periods examined (a nonparametric test gave significance at the .01 level)." They conclude that "the market may not adjust instantaneously and correctly for every item of information that becomes available." Surprisingly, Jones and Litzenberger found that this intermediate stock price trend (17 percent versus 5 percent for the market) happened only for companies with increased earnings. Those companies with lower earnings than expected did not decrease significantly.

The study is not a complete test of market efficiency, since the authors did not show that the profits from the trading rule exceed the cost of information processing and transactions. "A computer is necessary to examine a large quantity of data in a reasonable period of time," and "although a small investor could use similar techniques on a more limited scale," the effectiveness of the latter approach has not been researched.

Another problem is that the study does not look at intermediate price relatives. Rather, it focuses on the abnormal rate of return that could have been earned and ignores the speed of adjustment, other than the obvious implication that the time period of adjustment is less than six months. Thus, Jones and Litzenberger tell us little about their intermediate stock price trend.

Reconciling the Two Studies

The Ball and Brown study and the Jones and Litzenberger study arrive at completely different conclusions regarding market efficiency. One explanation is that there are differences in the implied decision rules of the two studies. A simple model is useful as an analytical framework to more clearly understand the differences between the two decision rules.

Using the same notation as before, if we subtract unity from the quotient of actual EPS divided by expected EPS, we can define this number as the Relative Forecast Error (RFE):

$$RFE = \frac{EPS_t}{E(EPS_t)} - 1 \qquad (3)$$

If this number is positive, we expect a price increase, and if it is negative, we expect a price decrease. Also, by assumption, the greater the RFE, the greater is the expected price change. The assumption is reasonable, as we would expect a greater resultant price change from a RFE of 50 or 60 percent than we would from a RFE of 1 percent.

Now, assume that in a certain time period we can examine a large number of securities and that we have a method by which to discern the expected EPS in the market of each with certainty. We can, therefore, calculate a RFE for each security when the actual EPS number is published. Given these assumptions, we can array all the

RFE's of the securities into a distribution. Over a long period one would expect a unimodal distribution about zero.

Each study used a model to estimate the expected EPS_t, i.e., $\hat{E}(EPS_t)$. If this is substituted for the $E(EPS_t)$ in (3) above, it is easy to visualize a distribution similar to the one described above. This distribution is useful in analyzing the two studies.

The Ball and Brown study treats any security to the right of zero in the distribution as an "increased earning" security. Such a procedure will treat securities with large and small forecast errors equivalently when looking at price changes. If we assume that the forecast error distribution is approximately normal, in random sampling, then we can expect many more securities with small forecast errors than with large forecast errors. The net result is that any price changes resulting from large forecast errors sampled in this manner are likely to be swamped by small forecast errors.

Similarly, the Jones and Litzenberger study also uses a model to estimate conditional EPS, in this case quarterly EPS, and it also compares this to the actual EPS numbers. Differences exist because Jones and Litzenberger include in their sample only those companies with large relative forecast errors, the equivalent of looking only at the tails of the forecast error distribution. One expects these securities to have the largest price changes if the market is not efficient.

CHAPTER II

METHODOLOGY

Overview

This section presents some design considerations and an overview of the methodology. Following this section are other general methodological considerations, including earnings forecast models, residual analysis, and statistical tests.

This study has been designed to draw on previous studies where appropriate, to improve on such studies where possible, and to introduce new considerations where these may add to the analysis. For instance, it was decided to examine price (return) data on a daily basis. This particular approach has not been previously used, and it allows for the close examination of the adjustment process of the stock market to new EPS information. This particular feature of the design is one of the major differences between this and other studies of the adjustment process. The reason that examination of price data on a daily basis has not been done previously is probably that monthly data are more widely available and easier to use.

It was decided to examine the market adjustment process only for annual EPS numbers and not to examine

quarterly EPS adjustments, as annual numbers are probably the most important for price formation. The response of security prices to the publication of annual EPS numbers may depend in part on how the annual number compares to what could have been predicted on the basis of interim reports, most importantly, the third quarter report. The potential dependence of price changes on the third quarter report necessitated the development of an earnings prediction model which took into account the effect of interim reports on the market expectation of annual EPS.

Companies listed on both the New York and the American Stock Exchange were included in the sample. The unavailability of data precluded the inclusion of securities listed Over-the-Counter. Inclusion of American Stock Exchange (AMEX) listed securities should increase the generality of this study's conclusions, as other studies have examined only New York Stock Exchange (NYSE) listed securities (see Ball and Brown [3], Brown and Kennelly [9], Fama et al. [15], etc.).

Another general consideration is the necessity of incorporating risk in the analysis and abstracting from general market movements. The market model, which is closely related to the capital asset pricing model first formulated by Sharpe [32], Lintner [23] and Mossin [28], was utilized.

The general method utilized in this paper is quite simple. The Wall Street Journal was examined on a daily basis in selected months to determine the dates on which EPS numbers first became generally available to the public. At this point certain preliminary screening criteria (to be discussed presently) were applied to define and limit the sample. Once a sample which met the preliminary requirements was obtained, The Standard & Poor's Stock Guide was examined to determine the quarterly EPS numbers of the chosen companies. Comparison of the estimated expected annual EPS number and the actual annual EPS number of each firm in an earnings forecast model yielded the direction and degree of forecast error (equation 3). At this point certain secondary screening criteria were applied, and the sample was further limited.

Companies with both negative and positive forecast errors were included in the sample. In this paper a firm with a positive forecast error will be defined as a firm whose actual reported EPS number is greater than its estimated expected EPS number, estimated on the basis of the earnings models in this paper. A negative forecast error will be defined as a firm whose actual EPS is less than estimated EPS.

Once the companies had been selected, one year of daily price (return) data was obtained from the Standard &

Poor's ISL Daily Stock Price Tapes, beginning approximately four months before and ending eight months after the actual annual EPS number was published in The Wall Street Journal. Part of this year was utilized for an analysis of the reaction to the arrival of the EPS information (residual analysis), and part was utilized to estimate market parameters (discussed presently) necessary for the residual analysis.

Some General Considerations

The Standard and Poor's ISL Daily Stock Price Tapes were available in the University of Florida Systems Library from the second quarter of 1962 through the second quarter of 1972. The tapes contain one calendar quarter of daily prices, dividends, and stock split and dividend data for all companies on the New York and American Stock Exchanges. A program was written to retrieve the daily price data from the tapes and to calculate the daily holding period return (HPR) for each security in the sample in any particular quarter. The holding period return is defined as

$$HPR = \frac{P_{j,t} - P_{j,t-1} + D_{j,t}}{P_{j,t-1}} \tag{4}$$

where

$P_{j,t}$ = price of security j in time t

$D_{j,t}$ = dividend of security j in time t.

The t in this case corresponds to an increment of one day. The HPR may be thought of as the rate of return accruing to the holder of security j from holding this security from time period t-1 to time period t, in this case one day.

One of the problems of using daily price data is the difficulty of keeping track of the individual dates on which the annual EPS numbers of different securities are published. This problem was held to within manageable limits by including in the sample only those securities whose annual EPS numbers appeared in The Wall Street Journal between the dates of February 15 and March 20 of any particular year. These dates were chosen because most industrial firms have fiscal years ending on December 31, and a few months elapse before the results of a year's operations are summarized and made available. Thus, a majority of annual EPS numbers are made available between the two above-mentioned dates. The above procedure may possibly limit the generality of the sample somewhat, although there is no evidence that companies with December 31 fiscal years are systematically different from companies with different fiscal years. Somewhat more than half of all industrial companies in the United States have fiscal years ending on December 31.

Some companies furnish preliminary EPS numbers to The Wall Street Journal and then later report the final numbers. Other companies have only the final numbers

published. This study did not distinguish between preliminary and final numbers. Each security's publication date was cross-checked in The Wall Street Journal Index to insure that no previous annual EPS information had been reported either as a preliminary number or as news such as reported at a meeting of security analysts. Thus, all firms in the study had the first mention of the EPS number published between February 15 and March 20.

A residual analysis (discussed presently) was performed beginning twenty days before the publication of the EPS information and was continued until sixty days after this date. Since the annual EPS number was always published in the first quarter of the year after the year which it summarized, the above period of time always fell in the first two quarters. These two quarters were the middle two of the year of HPR's which were collected for each firm. The two outside quarters of this year were used to estimate the parameters of the market model. These two quarters corresponded to the fourth quarter of the year which the annual number summarized and the third quarter of the following year. In no case was the residual analysis performed during a time period which was also used to estimate the market parameters, preventing a bias in the estimation of those coefficients.

Earnings Models

Two models were used to estimate the expectation of annual EPS. The first model, a naive model, estimated that the market predicts this year's annual EPS number would be the same as last year's EPS number. This model shall be called the AF model, which stands for annual forecast. The second model estimated that the market predicted that the current year's annual EPS number would equal the sum of the first three quarters of actual EPS (previously published) and the fourth quarter results of the previous year multiplied by the ratio of the first three quarters of the current year to the first three quarters of the previous year. This model will be called the QF model, which stands for quarterly forecast.

The AF model was used as a preliminary screening device. The Wall Street Journal reports the previous year's results and compares these to the current year's results. The preliminary screen consisted of requiring at least a 20 percent difference between the current year's annual EPS and the previous year's annual EPS. Those companies which made it through this initial screen were then subjected to the QF model.

These models may be stated more precisely and rigorously in mathematical notation. Assume that a company's actual annual EPS number was published in The Wall Street Journal. The year of operations which it

summarizes contains four quarters, the first three quarters having been previously published and the fourth quarter results being implied in the annual number. Similarly, the previous year's annual EPS number summarized four quarters of results. The subscript *k* is used to denote the *k*th quarter relative to the first quarter of the previous year; the quarter just prior to the annual report (fourth quarter) is eight. Similarly, the first three quarters of the same year would be subscripted five, six, and seven, respectively; and the four quarters of the previous year would be subscripted one, two, three, and four, respectively. Thus, the actual annual results for the previous year for company *j*, which is nothing more than the sum of four quarters of operations for that year, may be denoted as

$$\sum_{k=1}^{4} EPS_{j,k}$$

and the immediate past year's results may be denoted as

$$\sum_{k=5}^{8} EPS_{j,k}.$$

The AF model assumed that the market predicts that this year's annual EPS will be the same as the previous year's EPS. Denoting the AF model estimate of this number as $\underline{\hat{E}_A}$, then

$$\hat{E}_A = \sum_{k=1}^{4} EPS_{j,k} \tag{5}$$

The annual forecast error (AFE) may now be defined as

$$AFE_j = \frac{\sum_{k=5}^{8} EPS_{j,k}}{\hat{E}_A} - 1 \tag{6}$$

This annual forecast error is always expressed as a fraction. It can easily be seen that the AFE is nothing more than the actual current year's EPS number divided by the estimate of its market expectation ($\hat{E}_A$) in the AF model, less one. For instance, if a company had earned \$1.00 the previous year and \$1.25 in the current year, then the AFE would be (\$1.25/\$1.00 - 1) = .25 or 25 percent.

Now, the preliminary screen may be denoted mathematically as:

$$|AFE| \geq 20\%.$$

There are several things to note about the AF model. First, it is not a very sophisticated model since it does not adjust for the expected annual growth in EPS. Since, however, few companies have growth rates in excess of 20 percent, the possibility of incorrectly classifying a company is small. Suppose, for example, that in the previous year a company's annual EPS were \$1.00, and that in the current year the company earned \$1.20. The company would be included in the sample as its earnings increased

by 20 percent. If the market projected that the company's earnings were going to increase by 15 percent (to $1.15), then the actual earnings of $1.20 would be viewed as an unexpected earnings increase by the market, and the price of the security would be likely to rise. Thus, the model "correctly" classifies companies as long as the market expects less than a 20 percent growth in annual EPS.

A second problem with the AF model is that it ignores interim reports of EPS. Thus, even though all companies in the sample have at least a 20 percent change in EPS, no assurance is given that there will be some price adjustment subsequent to the arrival of the actual number. Indeed, some people in the market may use only an AF model or an AF model with growth; i.e., they may ignore interim reports, but there is no assurance of this. A second model, which takes into account quarterly reports, is needed. This quarterly model was the second screen on EPS. The 20 percent AFE screen was utilized as the preliminary method for identifying those companies which were most likely to have a price adjustment. The second or QF (quarterly forecast) model was applied to all companies which survived this preliminary screen. Mathematically the estimate of the expected EPS using historical quarterly EPS information and denoted as $\underline{\hat{E}_Q}$ is defined as

$$\hat{E}_Q = \sum_{k=5}^{7} EPS_{j,k} + \frac{\sum_{k=5}^{7} EPS_{j,k}}{\sum_{k=1}^{3} EPS_{j,k}} (EPS_{j,4}). \qquad (7)$$

Verbally, this model predicts that this year's annual EPS number will be equal to the sum of the actual first three quarters of EPS plus an estimate of the current year's fourth quarter, which is estimated to be the previous year's fourth quarter results multiplied by the ratio of the current year's three quarter results to the previous year's three quarter results. Another way of stating this is that this year's fourth quarter results are expected to be the same as last year's but adjusted for the proportion of change in the first three quarters of results to the previous year's first three quarters of results.

The quarterly forecast error (QFE) for firm $\underline{j}$, always expressed as a fraction, is defined as

$$QFE_j = \frac{\sum_{k=5}^{8} EPS_{j,k}}{\hat{E}_Q} - 1. \qquad (8)$$

The calculated QFE_j may be of either sign; i.e., a company with an AFE of +20 percent will not necessarily have a positive QFE. It may have been that the first three quarters were exceptionally good for the firm and that the fourth quarter failed to live up to expectations.

<u>Companies which had a conflict in the predicted direction of forecast error between the AFE and QFE models were excluded from the sample</u>. This procedure was designed so that the direction of forecast error could be predicted with some reliability, constituting the second screen on earnings.

For instance, suppose that a company had earned \$1.00 per share the previous year and that each of the four quarters of operations that year had provided \$.25. Suppose also that in the current year the company had earned \$2.25, \$.50 a quarter for the first three quarters and then \$.75 for the fourth quarter. These increased quarterly results for the fourth quarter were better than would have been predicted on the basis of the first three quarters of results, and the model showed this; i.e., the company would have been included in the sample. This firm's AFE was \$2.25/\$1.00 - 1 or 125 percent and its QFE was (\$2.25/[\$1.50 + (\$1.50/\$.75)\$.25]) - 1 = ([2.25/2.00]-1) = 12.5 percent. Thus, both the AFE and QFE models predicted a positive forecast error. The above firm would not have been included in the sample if it had earned the same \$.50 a share in each of the first three quarters but only earned \$.25 in the fourth quarter even though the AFE is a positive 75 percent (\$1.75/\$1.00 - 1). The $\underline{\hat{E}_Q}$ model would have made the same estimate, but since the fourth quarter

was less than expected, the QFE would be ($1.75/$2.00 - 1) = -8.75 percent.

The above procedure was designed so that the direction of forecast error could be predicted with some reliability. Thus, we are relatively confident that any adjustment in price which occurs as a result of the new EPS information will be directly related to the direction of forecast error.

Residual Analysis

The method of residual analysis is fairly standard and straightforward. It relies on the fact that under certain conditions the return of a security may be disaggregated into a component which is related to the return on capital assets in general and a component which is related only to the specific security. This proposition may be stated mathematically in what has come to be called the market model. The model states that the returns of a security are a linear function of a general market factor such that

$$R_{j,t} = \alpha_j + \beta_j R_{m,t} + \upsilon_{j,t} \tag{9}$$

where

$E(\upsilon_{j,t}) = 0$

$cov(R_{m,t}, \upsilon_{j,t}) = 0$

and

$R_{j,t}$ = return on security _j_ in time _t_, including dividends and capital gains.

$R_{m,t}$ = return on the general market factor in time t.

$\upsilon_{j,t}$ = the individualistic factor representing the part of security j's return which is independent of $R_{m,t}$.

α_j, β_j = intercept and slope, respectively, of the linear relationship between the securities return and the return on the general market factor.

The $R_{j,t}$ and $R_{m,t}$ correspond to the holding period return (eq. 4) of the individual securities and the market index, respectively.

The return generating mechanism of (9), under some crucial assumptions, is consistent with the capital asset pricing model. These assumptions and the capital asset pricing model will be discussed in the next section.

The α and β obtain their economic interpretations from the capital asset pricing model. The β is a measure of the systematic or non-diversifiable risk of the security. The α is the average value, over time, of the systematic or individualistic portion of a security's return. It is assumed that the systematic portion of a security's return is captured by the α_j and $\beta_j R_{m,t}$. The individualistic component represents the classes of events which have impact only on security j. In an efficient market this $\upsilon_{j,t}$ will fluctuate randomly as random information about the security is instantaneously reflected in the market price (and return) of the security. It is this

interpretation of $\upsilon_{j,t}$ which has allowed researchers to use (9) to test market efficiency. The method, outlined below, estimates the market parameters of (9) for a large sample of securities and then tests whether, in fact, the $\upsilon_{j,t}$ fluctuates randomly.

The general method is quite simple. First, the market parameters of (9) are estimated during a time period when one believes that the assumptions of the model are met; most importantly $E(\upsilon_{j,t}) = 0$ and $cov(\upsilon_{j,t}, R_{m,t}) = 0$. (To the extent that this is not true, the estimated intercept will be biased.) In the present case, (9) was estimated using the two outside quarters of the one year of holding period returns (HPR's--eq. 4) which were collected for each security. Using the same quarterly designations as used in the earnings forecast models, these four quarters of HPR's would correspond to quarters 8, 9, 10, and 11 with 8 and 11 being used to estimate the market parameters. Notice that quarter 8 occurs during the fourth fiscal quarter of the companies in the sample. The middle two quarters of the year (9 and 10) contain the possible adjustment period of the security price to the new EPS information. These two quarters were not used in estimating (9). The S&P 425 Industrial Index was used as a proxy for the market index, $R_{m,t}$.

The next general step in the method is to use the estimated parameters (9) with the returns to the individual securities and the market portfolio to estimate $\hat{u}_{j,t}$

$$\hat{u}_{j,t} = R_{j,t} - (\hat{\alpha}_j + \hat{\beta}_j R_{m,t}) \qquad (10)$$

The $\hat{u}_{j,t}$ in any particular *t* represents that portion of the security's return which reflects events which are company specific after abstracting from risk and general market movements. In this study these $\hat{u}_{j,t}$ were estimated for each security in the sample for eighty-one separate days. These eighty-one days began twenty days prior to the publication of the annual EPS number in *The Wall Street Journal* and continued for sixty days after that date. Since there are typically five trading days in each week, this period corresponds roughly to one month before and continues for three months after the publication date. Only three months of residuals were collected after publication because any residual after that time cannot be attributed solely to the arrival of the annual number as the first quarter results of the new fiscal year were likely to be reported soon after the end of three months.

The next step in the analysis is to cross-sectionally average the estimated residuals, $\hat{u}_{j,t}$'s. This averaging is performed relative to the time period in which the expected disequilibrating information becomes

publicly available; e.g., in this study all t are measured relative to the publication of the annual EPS number. For instance, on day 0, the publication date, the firms in the sample would have all of their estimated residuals ($\hat{\upsilon}_{j,0}$'s) averaged together regardless of the chronological dates of publication. This is called an average residual, $\hat{\upsilon}_t$

$$\bar{\upsilon}_t = \frac{\sum_{j=1}^{n} \hat{\upsilon}_{j,t}}{n} \tag{11}$$

where there are n securities in the sample. In this study the sample was split into those firms with positive and those firms with negative forecast errors. There were eighty-one separate average residuals ($\bar{\upsilon}_t$'s) calculated for each of these subsamples.

Note that this $\bar{\upsilon}$ may be thought of as an average rate of return which would have been earned on a portfolio of n securities had they been purchased and held for the time period t (in the present case, one day) after abstracting risk and general market movements. If the market is efficient, the $\bar{\upsilon}$ in any t will be very close to zero as the price movement of the securities from which it is generated fluctuates randomly. A $\bar{\upsilon}$ which is significantly different from zero in a statistical sense is an indication of market inefficiency with respect to the information being examined.

If more than one time period is being examined, then these $\bar{\upsilon}_t$'s may be accumulated (added) to form a cumulative average residual (hereafter CAR)

$$CAR_T = \sum_{t=0}^{T} \bar{\upsilon}_t \tag{12}$$

where there are T time periods to be examined. The CAR shows the cumulative effects of the wandering of the return of the securities of interest around the market line. A CAR in this study was calculated from day zero to day sixty after the publication of the earnings announcement and from day -20 to day +10 relative to the publication. Each was calculated for both negative and positive forecast errors.

The $\bar{\upsilon}$'s may be accumulated in such a way that the resulting index, called an Abnormal Performance Index (API), may be interpreted as the rate of return accruing to the holder of an equally weighted portfolio of all the n securities in the sample, had the holder purchased them at time period t relative to the arrival of the information of interest and held them until day T.

$$API_{T+N} = \prod_{t=T+1}^{T+N} (1+\bar{\upsilon}_t) \tag{13}$$

where the API is compounded from period T+1 to T+N.

It can be seen that the CAR and API correspond to the well-known arithmetic and geometric rates of return.

The differences between calculated values of arithmetic and geometric rates of return are trivial at low rates of return (less than 15 percent). In this study, where the typical $\bar{u}$ was less than one-half of one percent, the API and CAR gave essentially similar results. The *cumulative* difference between the two was never greater than .2 percent after sixty days.

An operational definition of market efficiency with respect to publicly available information has not been satisfactorily formulated in the literature. In some cases the market is deemed efficient if it "rapidly" adjusts to new information. The term "rapidly" has never been specified in terms of time periods. As Ball [1] says, "The Efficient Market Hypothesis is limited in operational content until the speed of adjustment is specified precisely." In other cases, the market is deemed efficient if it was not possible to earn an abnormal rate of return by trading on the information as soon as it became publicly available. Similarly, some studies have compared the abnormal rate of return to transactions costs.

Regardless of the criterion of efficiency deemed appropriate, the $\bar{u}$'s and CAR may be used to test efficiency. Since the $\bar{u}$'s may be expected to fluctuate randomly about the market line in an efficient market, a test of market efficiency is whether or not this average residual ($\bar{u}$) is

significantly different from zero. That is, if it were possible to earn an abnormal rate of return by trading on the basis of some information available in time period $\underline{t}$, then the market had not fully reflected that information.

If the market is inefficient, the average residual may also be used to test the speed of adjustment by examining the number of $\underline{\bar{\upsilon}}$'s (time periods) after the arrival of the new information it takes for the average residual to become insignificantly different from zero.

If the disequilibrium lasts more than one time period, then the CAR may be used to measure the rate of return from trading on the new information when it became publicly available and holding the securities for as long as the disequilibrium persisted. The ending value of the CAR may be compared to percentage transactions cost as a further test of efficiency.

The CAR is also an appropriate device with which to examine the market adjustment process. An increase in the CAR implies an increase in the prices of the securities in the sample, and vice versa. A CAR which is wandering randomly suggests no systematic market adjustment to the information of interest. Thus, the pattern of market adjustment may be inferred from examination of the CAR.

The Capital Asset Pricing Model, the Parameter Estimation Problem, and the Normality Assumption

The Capital Asset Pricing Model

The most important assumptions of the Capital Asset Pricing Model (CAPM) are that (1) investors are risk averters, (2) returns are normally distributed, (3) a riskless rate of interest at which investors can borrow and lend as much as they want is in existence, and (4) expectations are homogeneous. If we define R_f as the risk-free rate and the other variables as before, then the CAPM suggests that the expected value of the return on any security j is:

$$E(\tilde{R}_j) = R_f + \beta_j(E[\tilde{R}_m] - R_f) \tag{14}$$

where

$$\beta_j = \operatorname{cov} \tilde{R}_j, \tilde{R}_m / \sigma^2(\tilde{R}_m) \tag{15}$$

The above model suggests that the return generating process is the market model (9) if $\alpha_j = (1-\beta_j)R_f$. Written in terms of excess returns, the model may be tested by adding an intercept to (14) and running the following regression using *ex post* rates of return

$$R_{j,t} - R_{f,t} = \alpha_j' + \beta_j(R_{m,t} - R_{f,t}) + \upsilon_{j,t} \tag{16}$$

The prime is to distinguish this intercept from α_j in (9). If the CAPM is correct, then the implication is that the α_j' in (16) will equal zero. The β in (16) is merely the systematic portion of a security's return expressed in units of market risk.

If we estimate (9) ex post instead of (16); then, if we believe that the assumptions of the CAPM are correct, the estimated $\hat{\alpha}$ in (9) impounds the risk-free rate and the systematic risk of the security as well as any systematic return α' that may accrue to the security due to an incorrectly specified CAPM or violation of the CAPM assumptions. The estimated intercept in (9) will be

$$\hat{\alpha}_j = R_f(1-\beta_j) + \alpha'_j \qquad (17)$$

Note that the risk-free rate in (16) is time subscripted. This means that variance in $\hat{\alpha}$ estimated in (9) may in part be due to shifts in the risk-free rate although this rate, which is thought to be closely approximated by the treasury bill rate, has historically been fairly stable relative to stock market stability.

Researchers have found that (14), which is called the one-factor model, is not well specified empirically (see Fama and MacBeth [16] and Blume and Friend [7]). The reason for this is that investors may not be able to borrow and lend as much as they prefer at the risk-free rate. To overcome this difficulty, researchers have formulated what is called a two-factor model (see Fama and MacBeth [16]). The two-factor model relies on the assumption of the existence of a risky portfolio, called the zero beta portfolio, which is uncorrelated with the market portfolio and which, when used in lieu of the riskless

rate, yields similar conclusions as to the linear relationship between market risk and return (see Black [4]). The point of this is that if we replace $R_{f,t}$ with $R_{z,t}$ (the zero beta return) then we arrive at similar conclusions as to the estimated intercept in (9). In this case the $\hat{\alpha}$ impounds the zero beta rate of return instead of R_f and some of the variance in $\hat{\alpha}$ may be due to changes in $R_{z,t}$.

The Parameter Estimation Problem

The typical procedure for testing market efficiency is to estimate (9) by pooling (using) *ex post* rates of return from time periods before (pre-period) and after (post-period) the arrival of the information of interest. These pre- and post-time periods are typically quite long; five to ten years of monthly returns are not unusual (see for example Ball and Brown [3] and Fama et al. [15]). It is assumed that by pooling these pre- and post-time periods to estimate the parameters in (9), accurate long-term estimates of these parameters are obtained. Most studies make the assumption that the parameters do not change between the pre- and post-time periods. If, in fact, the parameters do shift, the calculated average residuals and CAR may not give a true indication of the adjustment process.

The above problem may not be serious in the present case as only one year of return data is examined and it is

unlikely that there will be a marked shift in the market estimate of the risk of the firm during this short time period. This short time period does, however, give rise to another problem. Since only about three months of daily observations are used in each of the pre- and post-time periods to estimate the parameters in (9), short-term shifts in the risk-free rate (or the zero beta rate) or the systematic return to the security, see (17), may bias the estimate of the market parameters.

The problems of parameter stability and bias in the estimated parameters between the pre- and post-time periods are serious in this study. As a means of overcoming it, the parameters were estimated not only by pooling the two time periods but by estimating them in each period individually. The average residuals and CAR were also calculated using these parameters estimated in the pre-, post-, and pooled-time periods. Comparison of these three series of CAR's, should they be similar, would lead to the conclusion that parameter stability and biased parameters were not a problem. Significant differences in the CAR's would require the explicit consideration of the degree of bias present.

The Normality Assumption

One problem with using stock price rates of return is that observed return distributions have "fat tails" as

compared to normal or Gaussian distributions. It has been found that monthly rates of return probably conform better to a non-normal, symmetric, stable distribution than to the normal (see Mandelbrot [26] and Fama [13]). Since regression analysis and the planned statistical test of the average residual require the assumption of normality, there are some potential problems with using normal statistical techniques on stock returns, as members of the stable class of distributions do not converge to normality as the classical central limit theorem suggests.

Researchers have found that regression analysis and standard errors of means are robust with respect to violations of the normality assumption for monthly rates of return as long as the dispersion of the parameted stable return distribution is defined (see Officer [31] and Fama and MacBeth [16]). The evidence for daily stock price rates of return also suggests that the violation of the normality assumption is not serious. In a recent study, Blattberg and Gonedes [6] find that "for daily rates of return, the student model has greater descriptive validity than does the symmetric stable model," and "the student model has fat tails as does the stable model, but converges to normality for large sum sizes." Thus, the observed "fat tails" of stock return distributions is not a problem for statistical inference in this case because, as

Fama observes, "as long as one is not concerned with precise estimates of probability levels (always somewhat of a meaningless activity) interpretation of t statistics in the usual way does not lead to serious errors [16]."

Statistical Tests

Each of the eighty-one average residuals was tested to determine if its average value was significantly different from zero. The specific test performed was to divide the average residual by its calculated standard error. The resulting statistic, called a t statistic (not to be confused with t as in time period) is well known. A t statistic greater than two (approximately) indicates that the mean is significantly different from zero at the .05 level of confidence (approximately). A statistically significant average residual in the time period after the receipt of the EPS information implies that the market was inefficient; i.e., it had not completely adjusted for or fully reflected the information.

It was discovered that during certain time periods relative to the announcement date there was no observed statistical significance in the average residuals but that the CAR appeared to trend strongly. This trend was due (apparently) to noise in the average residuals after a certain length of time which inflated their standard errors and thus mitigated against statistical significance.

This trend in the CAR resulted from many of the average residuals being positive (or negative) but not statistically significant where market efficiency would imply that the average residuals fluctuate randomly. Thus, it became necessary to develop a statistical test of this observed trend in the CAR, as the existence of such a statistically significant trend implies market inefficiency.

One way to statistically test for the existence of such a trend in the CAR is to regress it against some time variable, i.e., fit a linear trend line through it.

$$CAR_t = a + b\ t + e \qquad (18)$$

where the t variable is nothing more than the integer value of the day t relative to the announcement day. If the slope coefficient of the time variable is significantly different from zero, then one can infer that a trend in the CAR exists, whereas market efficiency would imply that the CAR should wander randomly.

The above test is not appropriate if the error term of (18) is autoregressive (serially correlated). The least squares estimates in such a case are unbiased and consistent but are not efficient, which means that the estimated standard error of the estimators (a and b) will be biased. If the disturbances are autoregressive and we use (18), the calculated acceptance region for the estimators will be narrower than they should be for the specified level of significance. This would inflate the calculated

t statistics and bias them toward inferring significance.

In fact, the above regression does have an autocorrelated error term. The very procedure of accumulating (adding) the average residuals into the cumulative average forces the level of the cumulative average at one point in time to be dependent on its level in previous time periods. The nature of this autocorrelation would seem to be well approximated by a first order autoregressive scheme, which imposes an autocorrelation which dies out exponentially. Adding the average residuals over time would create an autocorrelation function which also asymptotically approaches zero, so that the first order autoregressive process should provide an adequate approximation.

An accurate estimate of the standard error of the estimator of the slope coefficient of (18) may be obtained by estimating the serial correlation coefficient in the data and using it to fit a first order autoregressive scheme to the same data.

$$CAR_t - \hat{\rho}CAR_{t-1} = a(1-\hat{\rho}) + b(t-\hat{\rho}t-1) + (e_t-\hat{\rho}e_{t-1}) \quad (19)$$

where $\hat{\rho}$ is the estimated serial correlation coefficient. Again, one must believe that a first order autoregressive scheme best describes the data (and it seems very reasonable) for (19) to be appropriate (for a discussion of this, see Cochrane and Orcutt [10]).

The above procedure is a test of whether or not the adjustment process is instantaneous. It can also be

used to test the abnormal rate of return which could have been earned. Since the CAR is expressed in terms of the rate of return which would accrue to the holder of an equally weighted portfolio of the securities in the average residual, the slope coefficient of (19) may be interpreted as an excess rate of return per day. An estimate of the cumulative rate of return is to compound this slope coefficient times the number of days over which the CAR was calculated (T in [12]). A confidence interval around this average cumulative rate of return may be closely approximated[1] by

$$CAR_T \pm \frac{2 \quad S}{(1-\beta^2)^{\frac{1}{2}}} \qquad (20)$$

where

$CAR_T = \hat{a} + \hat{\beta}(T)$, where $\hat{a}$ and $\hat{\beta}$ are the estimated coefficients in (19).

S = standard error of the regression.

---

[1]The confidence interval is only approximate because the above procedure ignores the fact that a and b in (19) are estimates and are not known with certainty. The factor ignored is of order 1/n, so that for large n its contribution will be small. In general terms, if we estimate $Y = a + bX + e$ and we want a confidence interval around a predicted Y, then

$$E(\hat{Y}) + E(\hat{a} + \hat{b}\,[X_0])$$

$$\text{Var }(\hat{Y}) = \sigma^2(1 + \frac{1}{n} + \frac{X_0^2}{\Sigma X_i^2})$$

The above procedure (20) is equivalent to ignoring the two terms on the right in the Var $(\hat{Y})$. But, since n and X_i are fairly large in this study (in fact, never less than sixty) the error in the confidence interval is very small.

This confidence interval was used to test the reliability of the abnormal rate of return indicated by the average cumulative rate of return.

CHAPTER III

RESULTS

Description of the Sample

The Earnings Digest section of The Wall Street Journal was examined between the dates of February 15 and March 20 in the years 1963 to 1971. These nine years corresponded to the availability of the ISL Daily Stock Price Tapes in the University of Florida Systems Library. The initial step in drawing the sample was to examine the current year's reported annual EPS numbers to determine those firms which had at least a 20 percent change from the previous year. The previous year's number is also reported in the Earnings Digest.

The next step was to examine Standard & Poor's Stock Guide to determine third quarter results for the current and previous years. At this point all Over-the-Counter securities were discarded as the Stock Guide includes the exchange listing of all firms. Annual and quarterly earnings were used to calculate the Quarterly Forecast Error (QFE) (equation 8) for each security. Those securities whose QFE conflicted in direction with their Annual Forecast Error (AFE) (equation 6) were discarded. At this point The Wall Street Journal Index

was utilized to cross-check the publication dates of annual EPS numbers and to insure that no previous publication of the number had taken place in The Wall Street Journal.

The final sample consisted of 158 firms, 113 with positive forecast errors and 45 with negative forecast errors. Table 1 presents a breakdown of these firms across security exchanges, and it also presents the average AFE and QFE for both positive and negative forecast errors. Of the 158 firms, 105 were listed on the New York Stock Exchange and 53 on the American Exchange. No attempt was made to manage the proportion of the two different exchanges in the sample.

TABLE 1

SUMMARY OF THE NUMBER OF FIRMS WITH NEGATIVE AND POSITIVE FORECAST ERRORS, OF EXCHANGE LISTINGS, AND AVERAGE OF PERCENTAGE FORECAST ERRORS

Forecast Error	# Firms	# NYSE Firms	# AMEX Firms	Average AFE	Average QFE
Positive	113	74	39	68.6	21.5
Negative	45	31	14	-44	-21.6
All Firms	158	105	53	36	9.3

The range of the positive AFE was 20 percent to 480 percent, and similarly, the range of the positive QFE was from 0 to 170 percent. The median QFE was 10 percent. Thus there was a positive skew to the distribution of

Quarterly Forecast Error. The range of the negative AFE was -20 percent to -93 percent, and the range of the negative QFE was 0 to -89 percent. Since no firms were examined with negative earnings, the AFE is bounded in a negative direction by -100 percent while the positive AFE is not bounded. This accounts for the difference between the average positive and negative AFE's. The positive and negative QFE's were of a similar magnitude.

Table 2 is a summary of the distribution of the firms whose numbers were examined among the nine years in the sample. The firms were fairly evenly distributed among the nine years, but there was a slight tendency for the negative forecast errors to occur more frequently in the later years and the positive forecast errors to occur more frequently in the earlier years.

An Analysis of Regression Results

The daily holding period returns (HPR's--equation 4) of all 158 securities were regressed against the daily HPR's of the S&P 425 Industrial Index. These regressions were run three times for each security in the sample; once using HPR's from the quarter just prior to the earnings announcement quarter (pre-period or period 8), once for the second quarter after the earnings announcement quarter (post-period or period 11), and once by pooling the HPR's from both time periods. This procedure yielded three sets

TABLE 2

SUMMARY OF THE DISTRIBUTION OF FIRMS AMONG DIFFERENT TIME PERIODS FOR THE TOTAL SAMPLE AND FOR POSITIVE AND NEGATIVE FORECAST ERRORS

Year	Total	Positive Error	Negative Error
1963	29	24	5
1964	20	17	3
1965	13	10	3
1966	31	27	4
1967	9	5	4
1968	9	7	2
1969	14	10	4
1970	16	6	10
1971	17	7	10
	158	113	45

of parameters for each security. Table 3 is a summary of the three sets of regression results for the total sample and for the sample divided into positive and negative forecast errors.

The market index, on average, explained about 11.7 percent of the variance of the individual security returns. This level of explained variance ($\underline{R}^2$) is roughly comparable to the results reported by Kaplan and Roll [21] using a weekly differencing interval. The range of $\underline{R}^2$'s was from less than 1 percent for several firms to 62 percent for one firm (Boeing).

The most striking feature of the results presented in Table 3 is the differences between the pre- and post-periods. There was a systematic tendency for the post-period to have a higher proportion of the variance of the individual security returns explained by the market index. The $\underline{R}^2$ is almost 70 percent higher in the post- than in the pre-period for the whole sample. The average estimated intercept is more than three times as large in the pre- than in the post-period for those firms with positive forecast errors (.149 percent versus .04 percent). The average intercept is negative in the pre-period and positive in the post-period for negative forecast error firms. There is also a significant shift (.05 level) in the <u>estimated</u> market risk of the firms in the sample. The average beta increased from .897 in the pre-period to 1.076 in the post-period.

TABLE 3

AVERAGES OF THE ESTIMATED MARKET PARAMETERS AND EXPLAINED VARIANCES IN THE PRE, POST, AND POOLED TIME PERIODS FOR ALL 158 FIRMS AND FOR FIRMS WITH POSITIVE AND NEGATIVE FORECAST ERRORS

Estimation Period	$\bar{\hat{\alpha}}$	$\bar{\hat{\beta}}$	$\bar{R}^2$
	Total Sample (158 Firms)		
Pre	.001013	.897	.086
Post	.000442	1.076	.146
Pooled	.000823	.98	.118
	Positive Forecast Errors (113 Firms)		
Pre	.00149	.949	.097
Post	.0004	1.08	.152
Pooled	.00113	1.04	.130
	Negative Forecast Errors (45 Firms)		
Pre	-.000194	.776	.056
Post	.000544	1.063	.131
Pooled	.000054	.817	.085

It is apparent from the above results that the estimates of the market parameters between the pre- and post-periods are quite different. The problem arises, therefore, of attempting to determine the cause of this estimation problem and of attempting to determine which set of market parameters is the most appropriate to use in performing the residual analysis to follow. Briefly, it was determined that the market parameters estimated in the post-period were more appropriate, as the parameters estimated in the pre-period were biased due to the way the sample was drawn. The remaining pages of this section will be used to present the analysis which led to this determination.

The estimated residual in each time period for each security is calculated by (10):

$$\hat{\upsilon}_{j,t} = R_{j,t} - (\hat{\alpha}_j + \hat{\beta}_j R_{m,t}), \tag{10}$$

and the average residual is calculated by

$$\overline{\upsilon}_t = \frac{\sum_{j=1}^{n} \hat{\upsilon}_{j,t}}{n}. \tag{11}$$

If the average residual is calculated for a sample of securities, it will be related to the estimates of their market parameters, i.e., substituting (10) into (11)

$$\overline{\upsilon}_t = \frac{\sum_{j=1}^{n} R_{j,t}}{n} - \left(\frac{\sum_{j=1}^{n} \hat{\alpha}_j}{n} + \frac{\sum_{j=1}^{n} \hat{\beta}_j R_{m,t}}{n}\right), \tag{21}$$

or $$\bar{\hat{u}}_t = \bar{R}_t - (\bar{\hat{\alpha}} + \bar{\hat{\beta}}\ \bar{R}_{m,t}) \tag{22}$$

Thus, the average residual in any time period is nothing more than the average return of the securities in the sample for that time period less the average systematic return of those securities and less the average systematic risk of the securities times the average return of the market portfolio in the time period. Note that in (22) the time period is measured relative to the announcement date of the new EPS information and thus the $\underline{\bar{R}_t}$ and $\underline{\bar{R}_{m,t}}$ represent many different chronological dates.

Equation (22) clearly demonstrates the purpose of using the market model (9) in a residual analysis to test market efficiency. If the market is efficient, then subtracting the average systematic return $(\bar{\hat{\alpha}} + \bar{\hat{\beta}}\ \bar{R}_{m,t})$ of a sample of securities from the average return of those securities in some time period (t-relative to some information availability) $\underline{\bar{R}_t}$, should yield approximately a zero return. This is because the $\underline{\bar{R}_t}$ represents many different chronological dates and thus should be a random number if the securities in the sample move randomly relative to the announcement date. If the market is not efficient with respect to the securities in the sample, then subtracting the systematic return from the average calculated return in a time period when the market is systematically adjusting for some new information will not yield a zero average

return. The above argument assumes that an unbiased estimate of the systematic portion of each security's return is obtained, as well as unbiased estimates of the market risk parameters.

The estimated $\underline{\beta}$ in the pre-period is slightly smaller than in the post-period. These differences are not likely to have a substantial impact upon the estimated residuals because the average $\underline{R_{m,t}}$ is likely to be quite small on a daily basis.[1] In a famous study, Fisher and Lorie [17] estimated that the average long-term annual rate of return of all securities listed on the New York Stock Exchange was about 9 percent. This means that, on average, the value of $\underline{R_{m,t}}$ on any particular day is likely to be on the order of .09/250 = .036 percent if there are 250 trading days in a year. The difference between the two estimated $\underline{\hat{\beta}}$'s is small (1.076 - .897 = .179), and thus the differences between calculated average residuals as a result of different estimates of $\underline{\beta}$ is likely to be very small (.179 x .00036 = .0000644).

---

[1]Time does not mean that the individual $\underline{R_{m,t}}$'s in different time periods cannot be quite large. It is the $\underline{\beta_j R_{m,t}}$ term which is used to adjust individual returns for systematic risk; i.e., if $\underline{R_{m,t}}$ is 1 percent in some time period, then a security with a $\underline{\beta}$ of .5 would have ½ percent subtracted from its return in the residual analysis, and a security with a $\underline{\beta}$ of 2 would have 2 percent subtracted from its return (eq. 10).

Contrary to the $\underline{\beta_j}$, the differences in the estimates of the $\underline{\alpha_j}$'s in the pre- and post-periods could cause a significant difference in the estimated average residuals and one does not know which set of estimated parameters is appropriate. Thus, the problem arises of determining whether or not the observed instability in the estimated average intercepts of (9) between the pre- and post-periods was caused by some CAPM related instability (perhaps instability in the zero beta rate of return) or by some sample specific instability. If the former is the case, there can be no confidence that the estimated intercept parameter is appropriate for the period of estimation of the average residual. If the latter is the case and if it can be established that either the pre- or post-period estimated parameters are an accurate estimate of the extant market relationship, then estimation of the average residuals is appropriate.

The average $\underline{\hat{\alpha}_j}$ in the pre-period is .001013 (more than one-tenth of 1 percent) which is equivalent to an annual return of 25 percent (.001013 x 250). The equivalent annual return in the post-period is 11 percent (.000442 x 250). Thus the difference between the average $\underline{\hat{\alpha}}$'s estimated in the pre- and post-periods is on the order of 14 percent on an annual basis and near one-tenth of 1 percent in each period (.081 percent). Thus the observed

differences in the $\hat{\alpha}$'s can significantly affect the average residual. The remainder of this section will identify potential sources of instability and bias in the $\hat{\alpha}$'s and will analyze the most probable source of bias in this study.

Recall from (17) that if one believes that the assumptions of the capital asset pricing model are met in the real world, then the estimated α_j impounds the riskless rate R_f, the systematic risk of the security β_j, and the systematic return of the security α_j' (if it exists). If one believes that the assumption of riskless borrowing and lending is not tenable, then R_f in (17) can be replaced by the zero beta rate of return R_z.

There is a potential source of bias in the estimation of α_j. If the regression model assumption $E(\upsilon_{j,t}) = 0$ is not met, then the estimated α_j will be biased; i.e., if $E(\upsilon_{j,t}) = \bar{\upsilon}_j \neq 0$ over some period of estimation, then this specification error will cause the estimated intercept to be biased by an amount equal to the $\bar{\upsilon}_j$. Adding this $\bar{\upsilon}_j$ to (17) we find

$$\hat{\alpha}_j = R_f(1-\beta_j) + \alpha_j' + \bar{\upsilon}_j. \tag{23}$$

A market disequilibrium in the estimation period will cause $E(\upsilon_{j,t}) \neq 0$ and by the above argument this trend in the residual can bias $\hat{\alpha}_j$.

Equation (23) identifies those sources of variance which are the most likely to affect the estimate of $\underline{\hat{\alpha}_j}$. Note that if all of the assumptions of the CAPM are met, the $\underline{\alpha_j}$'s (and the $\underline{\hat{\alpha}_j}$'s) will equal zero. If the two factor (zero beta model) CAPM is correct, then the $\underline{R_f}$ will be replaced by $\underline{R_z}$ (the zero beta return), $\underline{\alpha_j'}$ will be equal to zero, and the $\underline{\hat{\alpha}_j}$ will equal zero if there is no trend in the residual. The CAPM in both forms assumes that the market is efficient; i.e., there is no $\underline{\bar{\upsilon} \neq 0}$. Equation (23) may be used in an analysis of the $\underline{\bar{\hat{\alpha}}}$ resulting from estimating (9) in different time periods. The problem is to identify the most probable cause of the different $\underline{\bar{\hat{\alpha}}}$ and to determine which set of parameters is appropriate for the residual analysis.

Note that an average systematic risk of about one for the securities in the sample means that the riskless rate (23) is likely to contribute little to the $\underline{\hat{\alpha}}$. The average treasury bill rate (thought to be a reasonable surrogate for $\underline{R_f}$) was about 4½ percent during the period. The treasury bill rate also had a slight uptrend during the nine-year period, and since, chronologically, the pre-period is always before the post-period this uptrend, if it influenced the $\underline{\hat{\alpha}}$, should have influenced the post-period minutely. In fact, the post-period $\underline{\hat{\alpha}}$ was systematically lower than the pre-period.

A similar line of reasoning suggests that the zero beta rate of return (with the average $\underline{\beta}$ close to one), $\underline{R_z}$, probably did not cause the differences between the pre- and post-period $\underline{\bar{\alpha}}$'s, although the argument is less forceful than in the case of $\underline{R_f}$ since the zero beta rate has been typically estimated to be of a greater magnitude and variance than the riskless rate (see Fama and MacBeth [16]). Fama and MacBeth and Black, Jensen, and Scholes [5] estimate the monthly zero beta rate over many different time periods, and in no time period do they find a level of $\underline{R_z}$ which implies an annual return of greater than about 15 percent. Thus it seems very unlikely that the estimated annual return of 25 percent in the pre-period could have been caused by an exceptionally high zero beta return. However the possibility should be kept in mind if a more likely explanation cannot be found.

A fairly simple analysis demonstrated that the most likely explanation of the high $\underline{\bar{\alpha}}$ in the pre-period was a systematic tendency in the error term of (9) to have an expectation different from zero. This mis-specification of (9) caused the estimated intercept to be biased; i.e., in (23) the $\underline{\bar{\upsilon}}$ was different from zero. It was found that (9) was not subject to this same mis-specification when it was estimated in the post-period.

The pre-period corresponds to the fourth calendar quarter of a year in which each security in the sample had at least a 20 percent change in EPS from the previous year. Table 1 shows that, on average, EPS was about 69 percent greater than the previous year for the securities with positive forecast errors and about 44 percent lower for securities with negative forecast errors. The quarterly forecast error was about 21 percent (plus and minus) for both positive and negative forecast errors. This means that it is very likely that the firms in the sample had third quarter earnings reports which were different from those expected by the market. Since AFE was substantially greater than QFE, on average, the increase in AFE was likely to be caused by increased third quarter earnings as well as increased fourth quarter earnings. If the market is inefficient, then it may be adjusting for the third quarter EPS report during the fourth quarter: that is, the quarter used to estimate the pre-period market parameters. To test whether or not there was any statistical association between the direction and degree of Annual Forecast Error and the level of $\underline{\hat{\alpha}_j}$, the following regression was run for the whole sample:

$$\hat{\alpha}_{j,pre} = a + b(AFE_j) + e, \tag{24}$$

where

$\hat{\alpha}_{j,pre}$ = the estimated intercept of the market model of security j in the pre-time period.

AFE_j = the percentage difference between this year's annual EPS number and the previous year's annual EPS number.

The result of the regression was

$$\hat{\alpha}_{j,pre} = \underset{(4.06)}{.0013} + \underset{(3.415)}{.00000795}\ (AFE) \qquad (25)$$

The relationship was as significant when the regression was run for the pooled-time period estimate of $\hat{\alpha}_j$. There was no significant relationship found when the regression was run for the post-period $\hat{\alpha}_j$'s. Thus, the high level of $\bar{\hat{\alpha}}$ in the pre-period and in the instability between periods appears to have been caused by a mis-specification of the market model (9) during the pre-period.[2]

Note that the post-period is not subject to the same mis-specification. Although the manner in which the sample was drawn forced a high level of EPS in the pre-period, there is nothing inherent in the procedure which leads to a systematic price dis-equilibrium in the post-period. Researchers have found that high levels of EPS in one period are typically not followed by high levels of EPS in subsequent periods; i.e., EPS numbers seem to vary randomly. Since the post-period corresponds to the quarter in which stock prices would be adjusting for the second

[2]Note that the same results could have been obtained had the market been systematically anticipating fourth quarter EPS; i.e., it was very efficient. However, the residual analysis which is to be presented in the next section suggests that this is unlikely.

quarter EPS number, there is no reason to believe that this number will be related to the previous year's annual results. For empirical evidence in this regard, see Lintner and Glauber [24] and especially Brealey [8].

Comparison of the $\bar{\alpha}$ in the pre-period between the sample of positive and negative forecast errors is revealing. Those securities with positive forecast errors had an average estimated intercept of .00149, which is an equivalent annual return of 37 percent (.00149 x 250). If the market were adjusting for increased third quarter EPS during the fourth quarter (pre-period), then a $\bar{\upsilon}$ greater than zero is expected and the estimate of $\bar{\alpha}$ would impound the $\bar{\upsilon}$. For firms with negative forecast errors the $\bar{\upsilon}$ would be negative during the fourth quarter, and indeed the estimated $\bar{\alpha}$ is negative during that period (Table 3). This is the most convincing evidence that the different levels of $\bar{\alpha}$ were not caused by shifting levels of the zero beta return. Since there is a significant overlap in the time period of estimation for negative and positive forecast errors (Table 2), it is highly unlikely that the zero beta return biased the $\bar{\alpha}$ downward for negative forecast error firms and during the same time period biased the $\bar{\alpha}$'s upward for positive forecast error firms.

The reason for the differences in the average level of explained variance ($\bar{R}^2$) between the pre- and post-time periods may now be rationalized. During the

pre-period there is reason to believe that some of the total variance of return was caused by the adjustment process $\underline{\bar{\upsilon}}$ and, thus less of the total variance was explained by the market index.

The above analysis strongly suggests that the market parameters estimated in the pre-period are systematically biased away from the normal relationship and thus should not be used in the residual analysis. Examination of Table 3 reveals that the parameters estimated by pooling the pre- and post-time periods may also be severly biased. It was therefore determined that only the post-period estimated market parameters were appropriate for the residual analysis. That analysis will be presented in the next section.

Residual Analysis for Positive Forecast Error

The market parameters of (9) estimated in the post-time period were used in (10) to estimate residual for each firm starting twenty days before and running through sixty days after the publication of the EPS number. These estimated residuals were averaged cross-sectionally (11) relative to the publication date and accumulated (12) to form a cumulative average residual (CAR). Table 4 shows the average residual (11) for all firms with positive forecast errors for the publication date of EPS and ten days thereafter. The corresponding $\underline{t}$ statistic for each of these

TABLE 4

THE AVERAGE RESIDUAL, t STATISTIC, AND CUMULATIVE AVERAGE RESIDUAL FOR POSITIVE FORECAST ERRORS ON SELECTED DAYS AFTER THE EARNINGS ANNOUNCEMENT

Day	$\bar{u}$	t of $\bar{u}$	CAR
0	.01097	3.89	.01097
1	.00517	2.22	.01614
2	.00375	1.53	.01989
3	.00204	1.02	.02193
4	.00312	1.22	.02505
5	-.00125	- .54	.02381
6	-.00033	- .10	.02347
7	-.00218	-1.16	.02128
8	-.00360	-1.58	.01769
9	-.00212	-1.01	.01555
10	-.00244	-1.28	.01312
15			.0153
20			.0172
25			.0260
30			.0307
35			.0327
40			.0463
45			.0514
50			.0491
55			.0495
60			.0577

average residuals is also presented, as is the CAR for these eleven days. After day 10 the CAR is shown every five days until day 60.

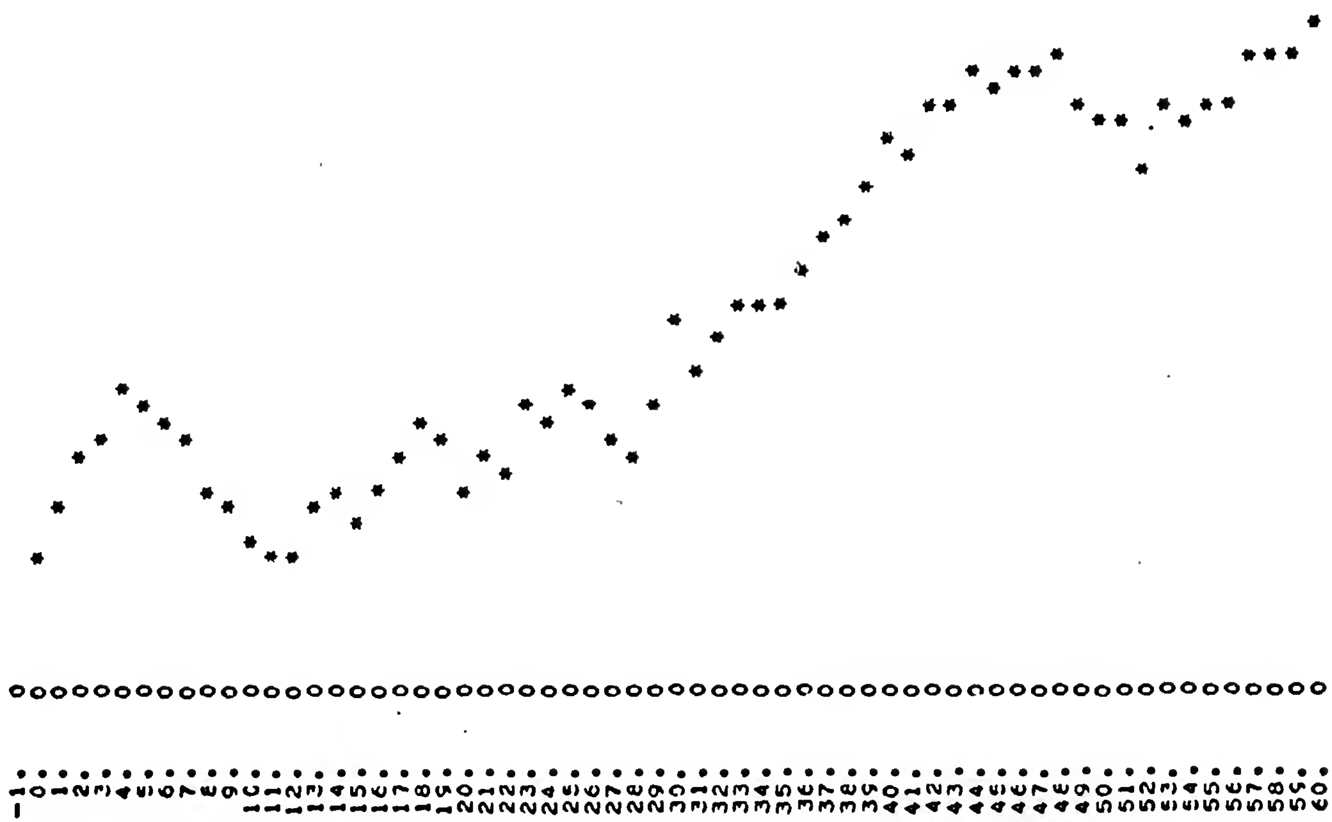
The *t* statistic for the average residual is calculated by dividing the average residual by its standard error (estimated standard deviation divided by the square root of the sample size). A *t* statistic greater than two implies an average residual which is statistically different from zero at approximately the .05 level of confidence.

The Cumulative Average Residual for firms with positive forecast errors is plotted in Figure 1. The first day plotted (day 0) corresponds to the day the actual EPS number was published in *The Wall Street Journal*. The CAR is plotted for sixty days after publication, which corresponds to about three calendar months. The plot of the CAR corresponds exactly to those numbers presented in Table 4. The remainder of this section will analyze and interpret Table 4 and Figure 1. This analysis will include the realized abnormal return, the adjustment process, and the speed of adjustment.

The Abnormal Return

The average residuals were statistically different from zero (.05 level) on the date of publication of the EPS number (day 0) and on the following day (day 1) as indicated by the *t* statistic of each individual average

Fig. 1. The Cumulative Average Residual for all firms with Positive Forecast Error, days 0 to 50 after the publication of the actual EPS number.



residual in Table 4. The cumulative return for these two days was about 1.6 percent. Current transactions costs are on the order of 1 percent on both the buy and sell sides for large round-lot transactions. Since the CAR did not reach the necessary 2 percent on the two days in which the average residuals were statistically significant, it was not possible to have earned an abnormal return.

Examination of Figure 1 reveals that, while the individual average residuals were not statistically significant after day 1, the CAR appeared to trend strongly upward from about day 12 to about day 45. The CAR maintained its relatively high level until day 60; its ending value was 5.77 percent. The cumulative return of 5.77 percent is 3.77 percent greater than the average 2 percent transactions costs necessary to buy and sell securities in large round lots. (This assumes that the securities were purchased at the closing price on the days prior to day 0.) This abnormal return may be an indication of market inefficiency, but since the individual average residuals which comprise the CAR are not generally statistically significant (.05 level), the 3.77 percent abnormal return may have been due merely to chance occurrence.

To test for the existence of a statistically significant trend, the CAR in Figure 1 was regressed against the integer value of the day relative to the publication

day; i.e., (19) was run. The results of that regression are summarized in Table 5.[3] The *t* statistic of the slope coefficient indicates that the slope is statistically significant at the .01 level. This regression line is plotted against the CAR in Figure 2.

TABLE 5

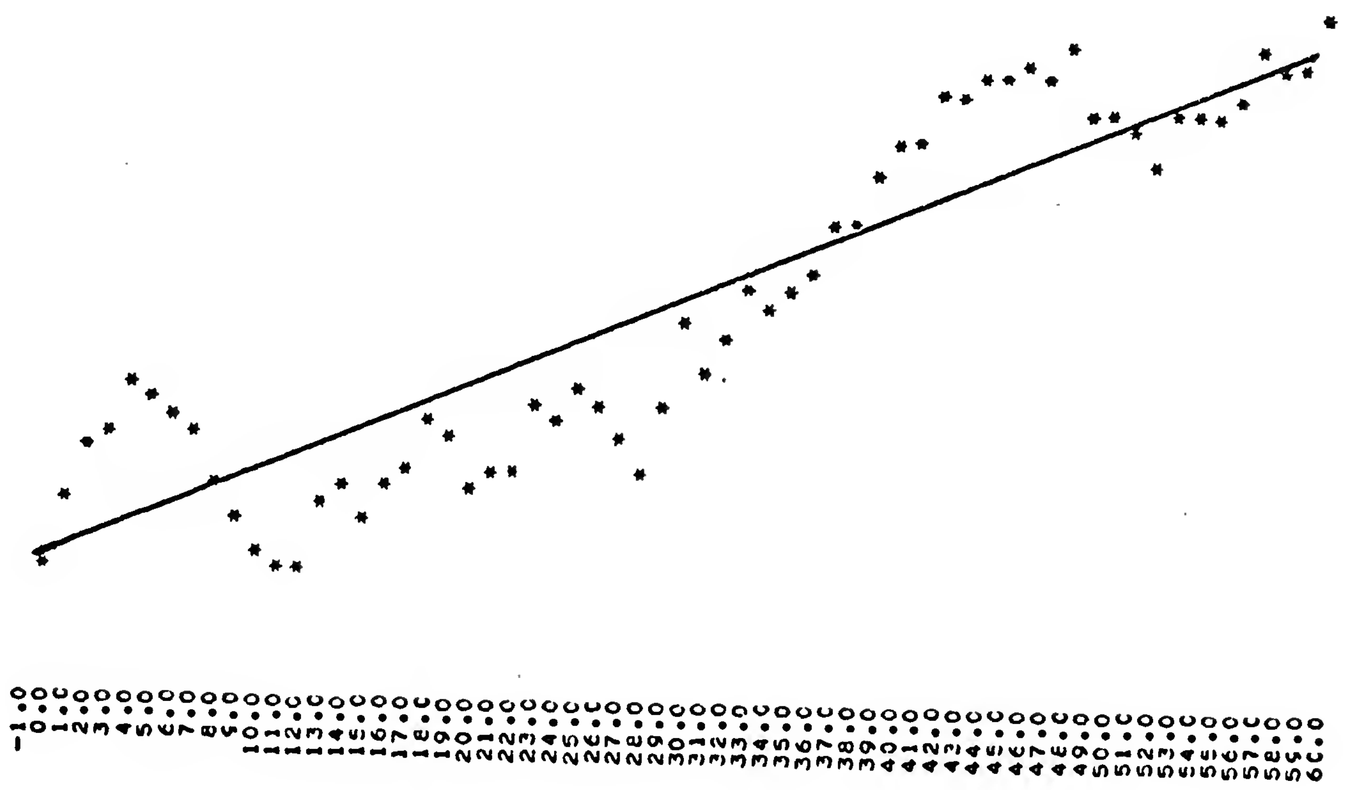
SUMMARY OF REGRESSION TESTING THE STATISTICAL SIGNIFICANCE OF THE CUMULATIVE AVERAGE RESIDUAL FOR POSITIVE FORECAST ERRORS AFTER ADJUSTING FOR SERIAL CORRELATION

Days	Rho	a	b	S	R^2
		(t)	(t)		
0-60	.85	.0129	.00069	.00286	.962
		(2.38)	(5.08)		

Because the CAR is scaled in percentage units and the independent variable in (19) is an integer representing one day, the slope coefficient in Table 5 may be interpreted as an average rate of return per day, and the cumulative return on any particular day may be predicted from (19). This predicted cumulative average return is of interest because the regression results may be used to

[3]Examination of the $\underline{R^2}$ term indicates that the first order autoregressive scheme was appropriate. The regression coefficient and the serial correlation coefficient together explain 96 percent of the variance of the CAR.

Fig. 2. Linear trend line fitted to the Cumulative Average Residual for all Positive Forecast Error.



generate a confidence interval around any particular day's predicted cumulative average return (20).

The upper and lower 95 percent confidence limits for the regression line plotted in Figure 2 are plotted in Figure 3. Note that these confidence limits are only approximate and that the true lines can be expected to bow slightly at the ends. As indicated in Chapter 2, the error in the confidence limits is likely to be small.[4]

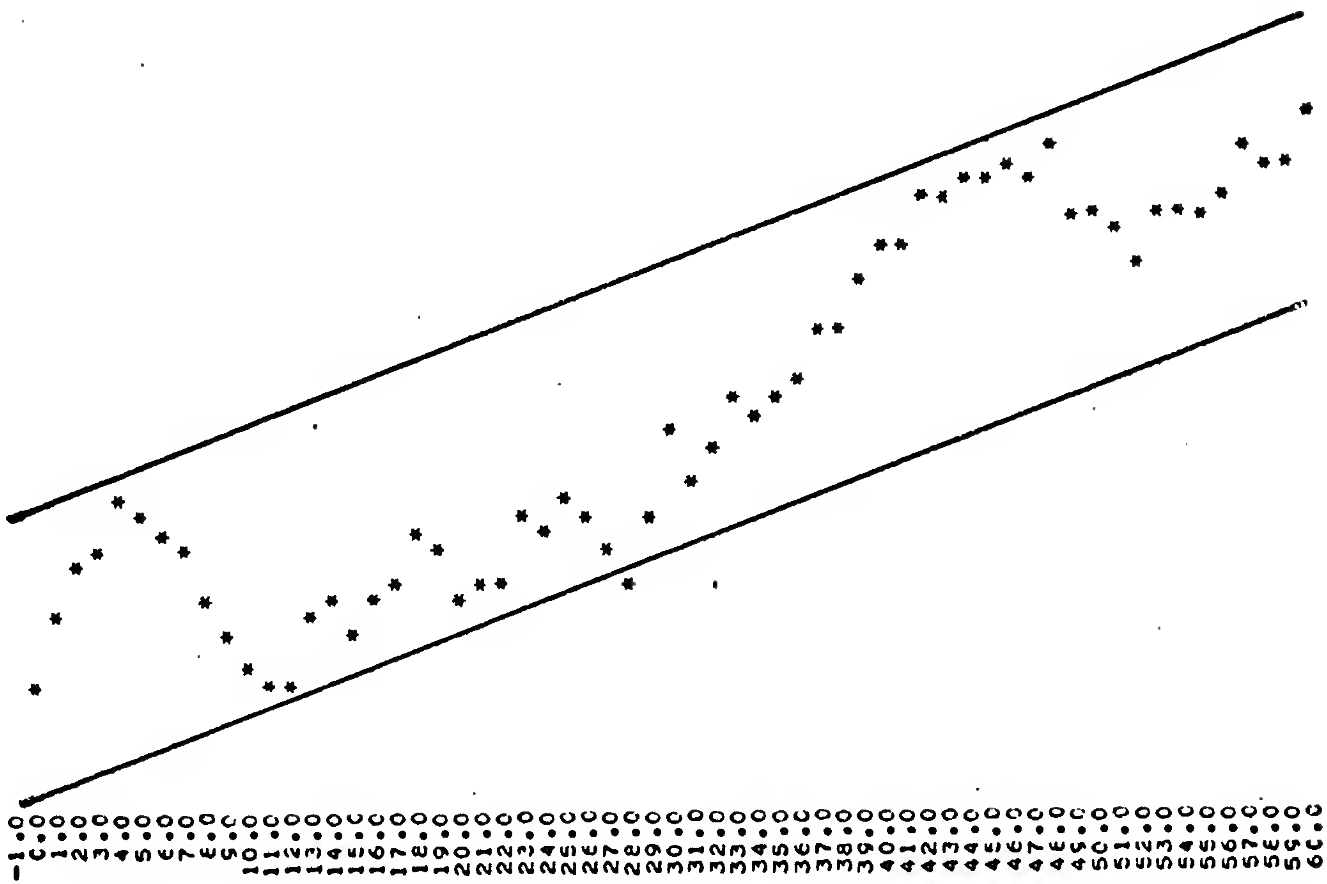
The most interesting part of the regression line and its confidence limits is the predicted cumulative average rate of return on day 60, the ending day in the analysis. This predicted cumulative average rate of return may be interpreted as the average rate of return accruing to the holder of an equally weighted portfolio of all of the securities in the sample if held from day 0 to day 60. Using the numbers in Table 5, the predicted cumulative average rate of return on day 60 is 5.43 percent. The 95 percent confidence limits around this predicted point (20) are approximately 4.35 percent to 6.51 percent.

The lower confidence limit of 4.35 percent is an indication that the purchaser of an equally weighted portfolio of the securities in the sample would have earned a minimum of 2.35 percent on average, after transactions

---

[4]The error is on the order of 1/n times the absolute value of the confidence limit. Since *n* is 60, the error is on the order of 1.6 percent of the confidence limit.

Fig. 3. The 95 percent confidence interval around the Cumulative Average Residual for Positive Forecast Error.



costs, with a 95 percent level of confidence. This return was in excess of the normal market return. Since this return accrued over a three calendar month period, if one assumes such investment opportunities are available year round, then this 2.35 percent is equivalent to an annual excess return of 9.4 percent (2.35 x 4). If one assumes that the average rate of return of 5.43 percent can be earned each three months, then the equivalent annual excess return is 13.7 percent ([5.43-2] x 4), after allowing for transactions costs and normal market returns.

The above results and analysis are an indication that market inefficiencies existed with respect to the securities in the sample in the time periods in which they were examined. The existance of a statistically significant (.01 level) trend in the CAR indicates that the market did not instantaneously adjust to the new information, and the 95 percent confidence interval around the predicted average CAR indicates that an excess return could have been earned had one acted upon the publicly available EPS information as soon as it became available.

The above abnormal return could have been earned by using a fairly simple investment strategy or decision rule, although the actual profit from such a strategy may not have been as large as it would seem. The strategy would require examining the earnings reports in <u>The Wall</u>

Street Journal on a daily basis and *immediately* purchasing those securities which met the necessary criteria implied in (6) and (8). To the extent that one is not able to immediately purchase such securities, the minimum 2.35 percent abnormal return may be decreased. For instance, if the approximately 1 percent average increase on day 0 occurs early in the day, then an investor who was unable to purchase early on this day would have the average 2.35 percent abnormal return decreased to 1.35 percent. This might be a problem for some investors who only receive *The Wall Street Journal* after a day's delay. If the individual investor could not afford to buy in large round lots, then the abnormal return could be further pared in transactions costs which can be greater than 4 percent for odd-lot purchases and sales.

Another danger is that the individual investor may be insufficiently wealthy to properly diversify himself, and thus he may be subjected to the gambler's ruin. The point of this discussion is that while this study may have demonstrated a fairly strong degree of market inefficiency, the individual investor should be very cautious in trying to implement such an investment strategy unless he tests such a strategy over a long period of time without actually investing.

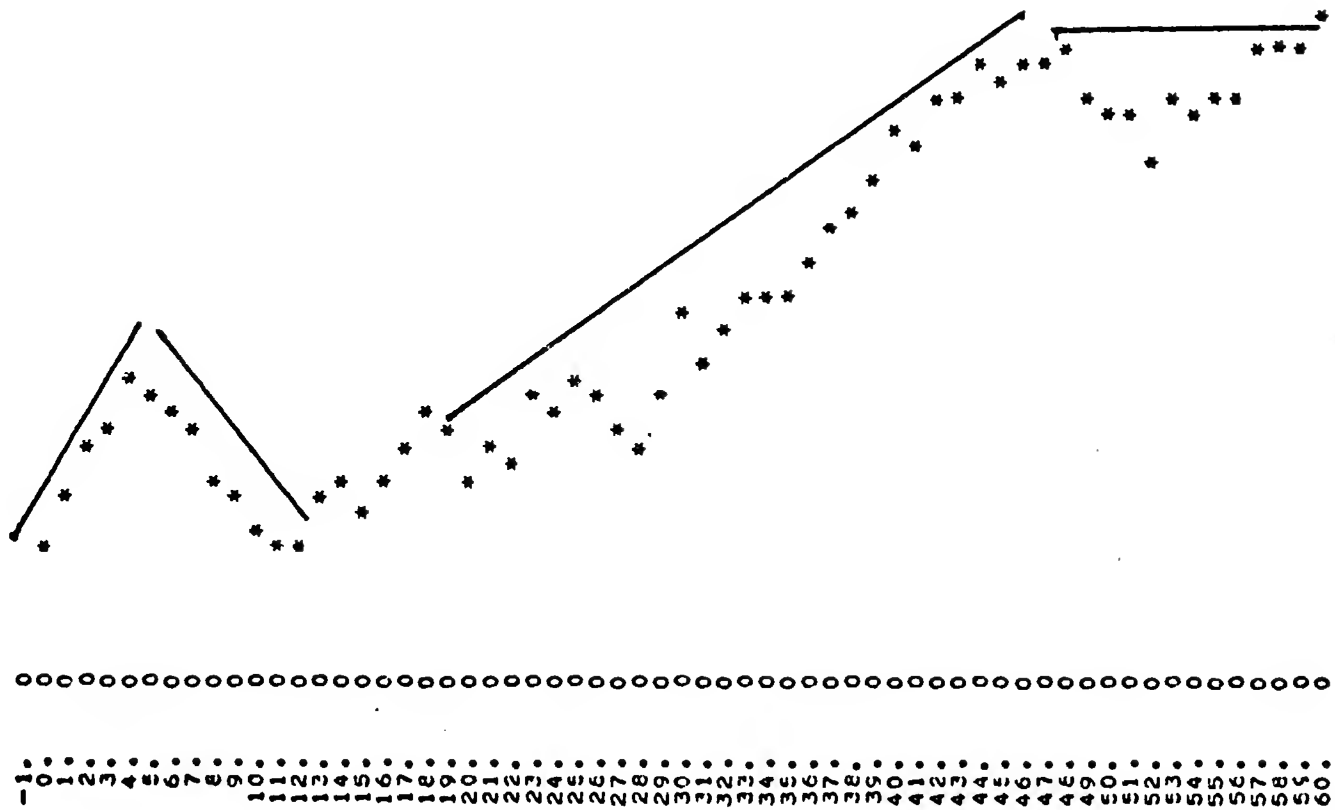
The Adjustment Process

There appear to be three distinct stages in the adjustment process of stock prices to unexpected increases in EPS. These three stages are illustrated in Figure 4; (lines are drawn as illustrations and with no pretense of accuracy). The first two stages took place during the first ten to twelve days after publication of the actual EPS number in The Wall Street Journal. The first stage consisted of a rather smooth and uninterrupted run-up in price for about five market days (one week) after publication. The greatest percentage move (about 1 percent, see Table 4) occurred on the publication day. This move was statistically significant at the .05 level as was the move on the following day. The average cumulative price increase was 2½ percent which was reached after five market trading days.

After the rather strong spurt of price increases, there was a five to seven day period of rather smooth and persistent price decreases. None of these price decreases during the second stage were statistically significant (.05 level) although several tended toward significance. The average cumulative price decrease was about 1¼ percent. This reduced the initial price run-up to about 1¼ percent.

After the initial two stages in the adjustment process, the market appeared to enter a third stage lasting

Fig. 4. The three stage adjustment process of the Cumulative Average Residual, Positive Forecast Error.



from about day 15 after publication of EPS to about day 45. This stage consisted of a persistent drift upward in the cumulative average residual, while only a few of the average residuals which comprised the CAR were statistically significant. Several of the average residuals between days 15 and 30 were negative, causing the increase in the CAR to be quite jerky. Beginning at about day 30 the CAR began to trend upward more smoothly than during days 15 to 30. This trend lasted until about day 45 after the announcement.

After about day 45 the CAR appeared to vary more randomly than during the first forty-five days. It is possible that the market had completed its adjustment by day 45 and was in equilibrium, although it is not clear that this was so. It is possible that the market began to anticipate first quarter EPS during this period (days 45 to 60). The preannouncement movement in the CAR will be examined and discussed in a subsequent section.

From the above discussion it appears as though there is a three-stage adjustment process involved in the market reaction to earnings forecast errors. A rationalization of this situation may be offered involving the mechanism whereby information is disseminated to and interpreted by investors. Specifically, the initial two stages of the adjustment may be a market reaction to incomplete earnings

information in The Wall Street Journal. That is, the price may initially increase as a result of publication of the EPS number, but the market may not have sufficient detail to sustain the initial price run-up. Publication of the annual EPS number in The Wall Street Journal is accompanied by only a bare minimum of the fundamental conditions surrounding the EPS number, usually only total sales, total costs, earnings and EPS numbers.[5]

The initial price reaction may cause technical interest which may cause the market to over-react in the first stage and as a result to decrease in the second stage. Thus, it appears as though the initial run-up in price and subsequent decrease is a possible over-reaction to incomplete information.

The third stage may result from a lag in the availability of the annual report to investors and analysts.[6] After about day 15, details of the year's operations become available in the annual report. This

---

[5]A supplementary cause of the initial two stages may be the actions of a group of investors who trade on the basis of annual EPS numbers as compared to the previous annual EPS number and not on the basis of improved fourth quarter results.

[6]A small study conducted at the University of Florida revealed that over a one-month period in March 1974, there was an average of about a three-week lag between publication of the annual EPS number in The Wall Street Journal and the arrival of the annual report of the company at the University of Florida libraries.

more complete information may cause the cumulative average residual to begin to drift upward. The detail in the annual report may cause shareholders to reevaluate the long-term investment worth of the firm in question and to, perhaps, re-balance portfolios. At the same time it is to be expected that analysts will reevaluate the firms on the basis of the annual report and possibly issue buy or sell recommendations. The price changes in the third stage are permanent in nature reflecting the reevaluation of the long-term investment worth of the firms (price changes in the first stage were partially eliminated).

The fact that all of the securities in the sample have at least a 20 percent change in annual EPS may tend to exaggerate the initial adjustment process. If there are indeed some traders who buy and sell solely on the basis of annual EPS numbers and ignore interim earnings, then this study would tend to overemphasize the action of such traders when compared to the "normal" adjustment mechanism. It may very well be that the initial adjustment stage is much less pronounced for securities with less than a 20 percent change in annual earnings.

The Speed of Adjustment

If the above analysis is correct, then the adjustment process of the stock market to published annual EPS information apparently takes about forty-five days or about 2¼ calendar months after the publication of the

annual EPS number. This is entirely in keeping with the Ball and Brown [3] results, as they also found about a two-month adjustment process. If one concludes that the market had completed the adjustment process by the end of the forty-fifth day after the earnings announcement, then it is apparent that the market was out of equilibrium for about 75 percent of those sixty days. In this case we call the market out of equilibrium if it is moving in other than a random fashion. It appears from the statistical analysis that this is the case.

It would seem as though the two-month adjustment process would contradict the Jones and Litzenberger results that the adjustment took place over a six-month period. This, however, is not true. Since this two-month adjustment resulted in a permanent price change, it is to be expected that this price change would have persisted on average until the end of the six months.

It is interesting to note that the conclusions for market efficiency would be quite different had the third stage of the three-stage adjustment not taken place. The fact that the market took about ten days to adjust for the earnings announcement and that it eliminated most of the price change associated with the announcement would have been strong evidence of a fairly efficient market. The fact that the third trend existed and, what is more

important, that the price increase appeared to persist is evidence that the market has reevaluated its fundamental estimate of the worth of the securities in the sample and that this reevaluation and adjustment takes a considerable length of time.

It is not entirely clear that the adjustment process has been completed by the end of the forty-fifth day. The findings with respect to the anticipation of the annual EPS would suggest that a similar process might occur for quarterly EPS. If the first quarter earnings reports for most companies in the sample are published about three months (one quarter) after the annual report, then it may well be that there is some adjustment occurring during the last fifteen days also. If this is so, then it may be that the securities with highly unpredictable components of their EPS may never reach equilibrium in the sense that the market has completely adjusted for all available information.

Of course, it may very well be that the adjustment process for securities whose EPS are fairly predictable is indeed rapid because the arrival of the annual report could be considered to be no news to the market and thus little if any adjustment would be expected. The conclusions seem inescapable, however, that the capital markets were not very efficient with respect to the securities in this

sample if one uses the speed of adjustment as the criterion for efficiency.

Residual Analysis for Negative Forecast Error

Table 6 lists the average residual, *t* statistic, and CAR for the forty-five firms in the sample with negative forecast errors. Each is listed for the eleven days subsequent to the publication of the actual EPS number. In addition, the CAR is presented every five days from day 15 to day 60. Figure 5 is a plot of the CAR on a daily basis for days 0 to 60.

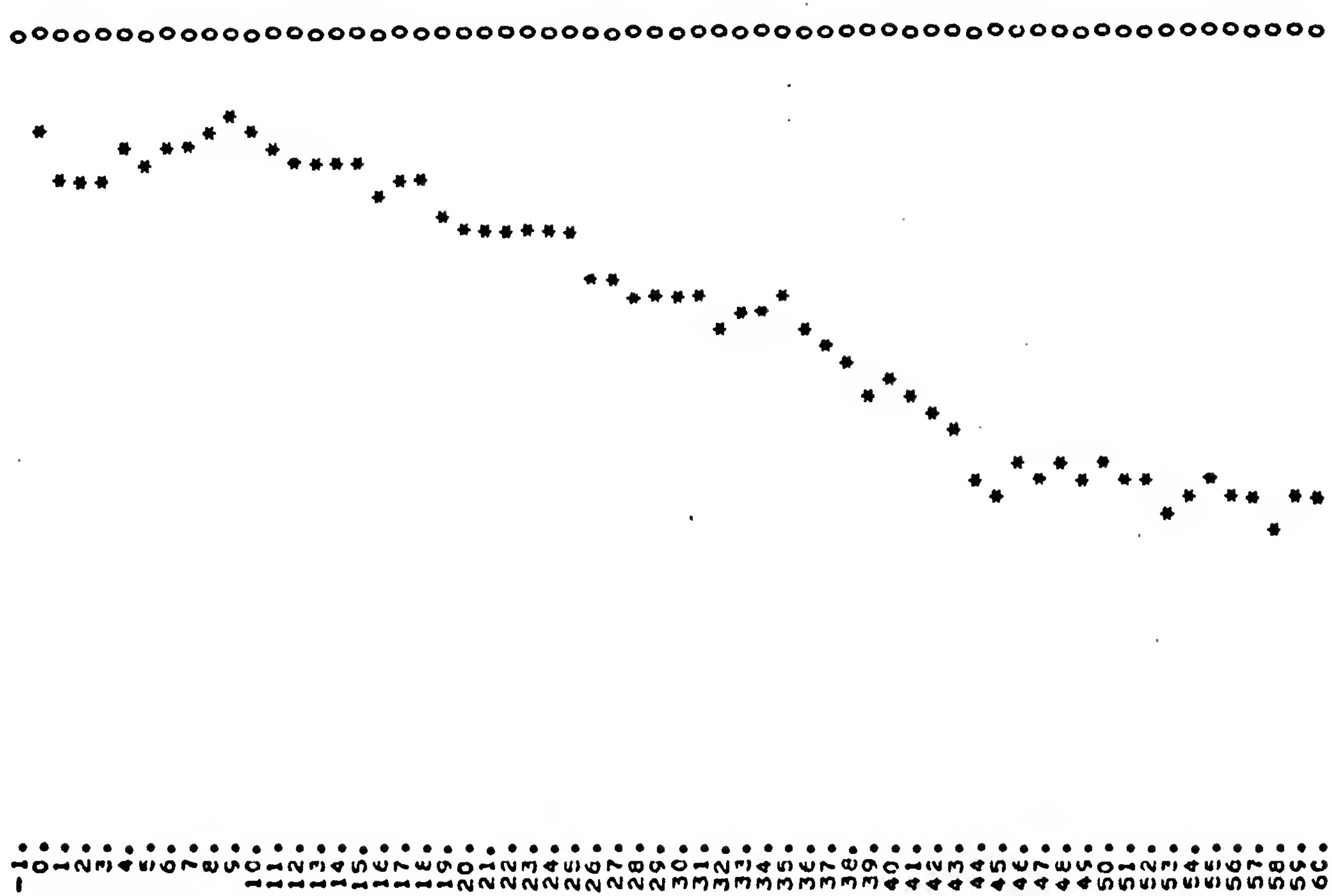
Examination of Figure 5 reveals that the CAR generally drifted downward after the announcement date as would be expected for firms with unexpected decreases in EPS. As with positive forecast errors, the first two average residuals are statistically significant at the .05 level. Those two days correspond to the EPS publication date and the following day. The total price move on the first two days was a negative 2.8 percent. This is .8 percent greater than average transactions cost. Thus, it appears profitable to sell short the securities in the sample, as an excess rate of return of .8 percent could have been earned. The initial price move was reversed after only two days, and the CAR appeared to have a slight upward drift from about days 2 to 10 after publication.

TABLE 6

THE AVERAGE RESIDUAL, t STATISTIC, AND CUMULATIVE AVERAGE RESIDUAL FOR NEGATIVE FORECAST ERRORS ON SELECTED DAYS AFTER THE EARNINGS ANNOUNCEMENT

Day	$\underline{\upsilon}$	t of $\bar{\upsilon}$	CAR
0	-.01740	-2.79	-.01740
1	-.01164	-2.15	-.02857
2	.00108	.23	-.02749
3	.00077	.20	-.02672
4	.00457	.92	-.02215
5	-.00147	- .41	-.02362
6	.00346	.50	-.02016
7	-.00142	- .32	-.02157
8	.00539	1.46	-.01618
9	.00288	.96	-.01331
10	-.00306	-1.16	-.01637
15			-.02525
20			-.03705
25			-.03492
30			-.04761
35			-.04983
40			-.06539
45			-.08736
50			-.08012
55			-.08254
60			-.08827

Fig. 5. The Cumulative Average Residual for all firms with Negative Forecast Error, days 0 to 60 after the publication of the actual EPS number.



Beginning at about day 10 or 11 the CAR started to drift downward again.

The ending value of the CAR was 8.8 percent after sixty days, but this level had been essentially attained by the end of forty-five days. Between days 10 and 60 few of the individual average residuals were statistically significant (.05 level), yet the CAR trended downward fairly strongly. As a test of the statistical significance of that trend, the CAR was regressed against the integer value of the day relative to the announcement day; i.e., equation (19) was run. The results of that regression are presented in Table 7. Table 7 reveals that the slope coefficient is statistically significant at the .01 level. This is an indication of a statistically significant trend in the CAR and this indicates that the market did not instantaneously adjust to the new EPS information.

TABLE 7

SUMMARY OF REGRESSION TESTING THE STATISTICAL SIGNIFICANCE OF THE CUMULATIVE AVERAGE RESIDUAL FOR NEGATIVE FORECAST ERRORS AFTER ADJUSTING FOR SERIAL CORRELATION

Days	Rho	a	b	S	R^2
		(t)	(t)		
0-60	.77	-.0064	-.00144	.0039	.976
		(-1.28)	(-10.95)		

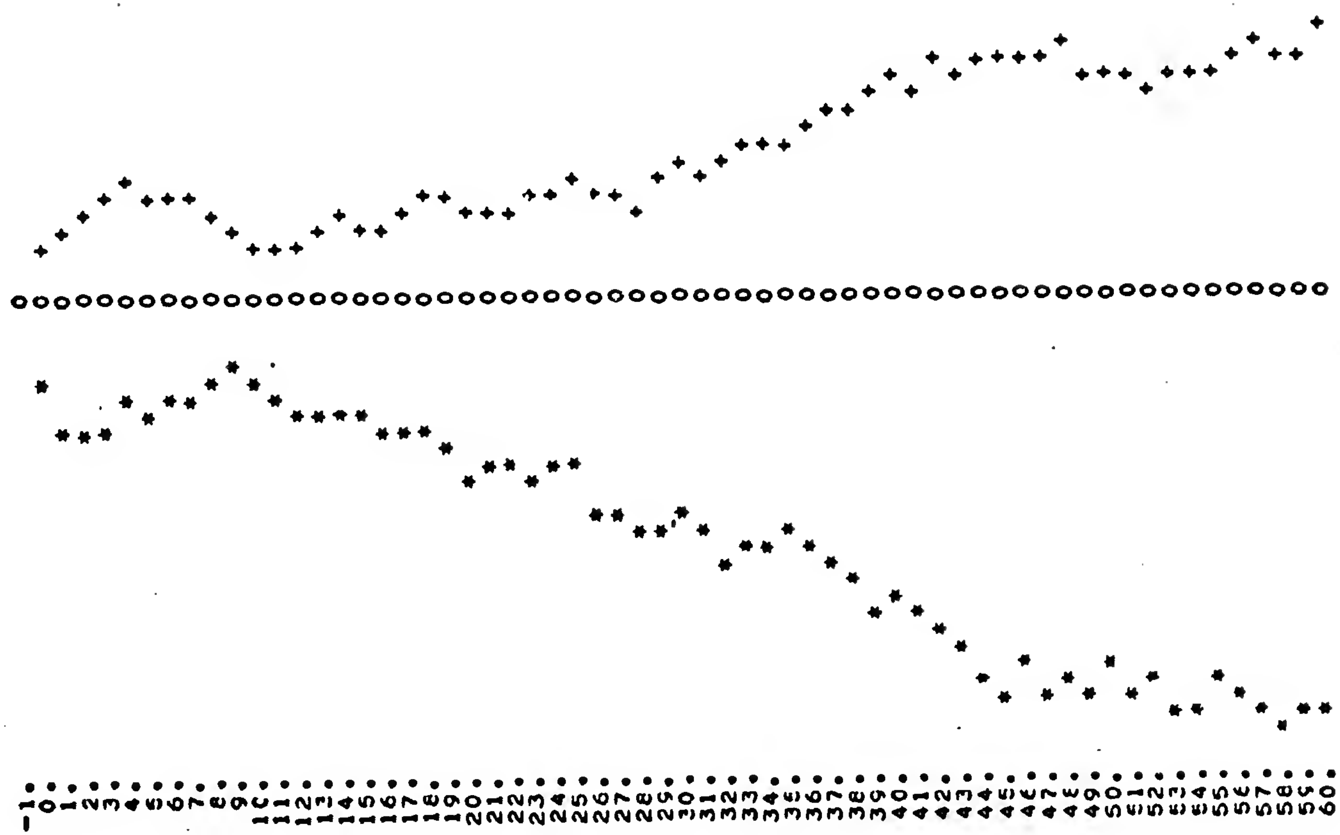
Using the estimated coefficients in Table 7, the estimated cumulative average return after sixty days was a negative 9.28 percent. The 95 percent confidence interval around this average return is negative 8.06 percent to negative 10.5 percent. Assuming average transactions costs of 2 percent, the minimum expected return for short sales is 6.06 percent with a 95 percent level of confidence. This translates to a 24.3 percent excess return on an annual basis if one assumes that such investments are available year round.

It appears as though the rate of return from selling short securities with negative forecast errors is considerably higher than the rate of return from long purchases of securities with positive forecast errors, at least for the securities in this sample. Recall that the Quarterly Forecast Error for both negative and positive earnings changes was an almost identical 21 percent (Table 1). One reason that the ending value of the CAR was greater for the negative series may be the finding that there is generally a greater percentage decline in price relative to a percentage change in earnings for unfulfilled earnings expectations than there is for earnings greater than expectations (see Neiderhoffer and Regan [30]). Another reason may be that the market actually projected some long-term growth in quarterly earnings, and thus the

actual Quarterly Forecast Error was actually greater than indicated by the negative QFE.

The similarities in the adjustment process of the stock market to negative and positive forecast error are illustrated in Figure 6, which is a plot of the CAR's for both negative and positive QFE's. The pattern of adjustment for the two series looks remarkably similar, almost like mirror images of each other; both exhibit statistically significant price changes on the day of the earnings announcement and the following day. These price changes are directly related to the direction of forecast error. Both series exhibit a second stage just after the first in which the prices of the securities move inversely to the direction of forecast error. This situation appears to be a correction for a possible over-reaction to the earnings announcement. Both series exhibit a price trend which is directly related to the direction of forecast error which begins 10 to 12 days after publication of the EPS number and lasts until about day 45. From days 45 to 60 both series appear more or less horizontal and thus appear to change in a random fashion, although it is not altogether clear that this is so. The fact that both series begin to trend in a direct relation to the change in EPS between days 10 and 15 seems to indicate that some common occurrence causes this trend, perhaps the arrival of the

Fig. 6. Comparison of the Cumulative Average Residual for Positive and Negative Forecast Errors, days 0 to 60.



actual annual report in the hands of investors.

Although the two series exhibit some remarkable similarities, there are also some distinct differences. The adjustment process for the first ten days appears to be slightly different. Both the negative and positive series peak in absolute value at about 2½ percent, yet it takes the positive series about five days to reach this level, while the negative series achieves a -2.8 percent in two large and significant jumps. (Recall from Table 1 that the average QFE for the two series were almost identical [21.5 percent versus -21.6 percent] and that the average AFE's were greater for the positive series [68.6 percent versus -44 percent].) One possible explanation for this is that the two significant moves for the positive series trigger certain technical indicators such as relative strength tests and cause investor interest on the basis of this information. This technical interest could cause the price to keep increasing for the extra few days. Such a mechanism is not available for negative price moves, so that the entire adjustment appears to take place in just two days.

The second stage of the adjustment process seems to be more smooth and less random for the positive than the negative series. Notice that the average residual tended toward statistical significance between days 5 and

10 for the positive forecast error series, but that the *t* statistics are near zero between days 2 and 10 for the negative series (see Tables 4 and 6). The indication is that whatever causes the second stage of the adjustment process, it is not as strong for the negative series as it is for the positive series.

Pre-Announcement Movements in the CAR

Examination of the average residuals and CAR prior to the actual announcement of EPS is of interest because it gives an indication of how the market anticipates the earnings announcement. The market may use many different sources of information in the anticipation process. Economy-wide movements and earnings of firms in the same industry may allow investors to form estimates of the future EPS of a firm and, perhaps, cause them to purchase or sell securities on the basis of such information. Movements in the CAR as a result of investors acting on such information would be an indication of an efficient market.

However, movement in the CAR caused by investors taking advantage of other sources of information could be an indication of market inefficiencies. Such sources of information include news leakages and insiders taking advantage of monopolistic sources of information. Unfortunately, it is impossible to tell if movements in the CAR prior to the EPS announcement are caused by

information of this sort or information about economy-wide or industry-wide movements. Examination of the CAR prior to the earnings announcements is, nonetheless, still of interest.

Figure 7 is a plot of the CAR for both positive and negative forecast errors beginning twenty days prior to and ending ten after the earnings announcement. Tables 8 and 9 show the average residual, _t_ statistic of the average residual, and the cumulative average residual. The CAR's in both cases started accumulating at day -20 or about one month before the announcement.

The direction of movement in the CAR's prior to the announcement date is directly related to the direction of forecast error. The CAR's begin a rather smooth trend in anticipation of the announcement approximately fifteen days (three weeks) before the actual announcement. Both positive and negative series reach a cumulative absolute value of 3.9 percent on the day before the announcement. The average residual is significantly different from zero (.05 level) on the day before the announcement for the positive series and on the second day prior to the announcement for the negative series.

The patterns of adjustment for the positive and negative series are again remarkably similar. The indication is that the anticipation and adjustment mechanism

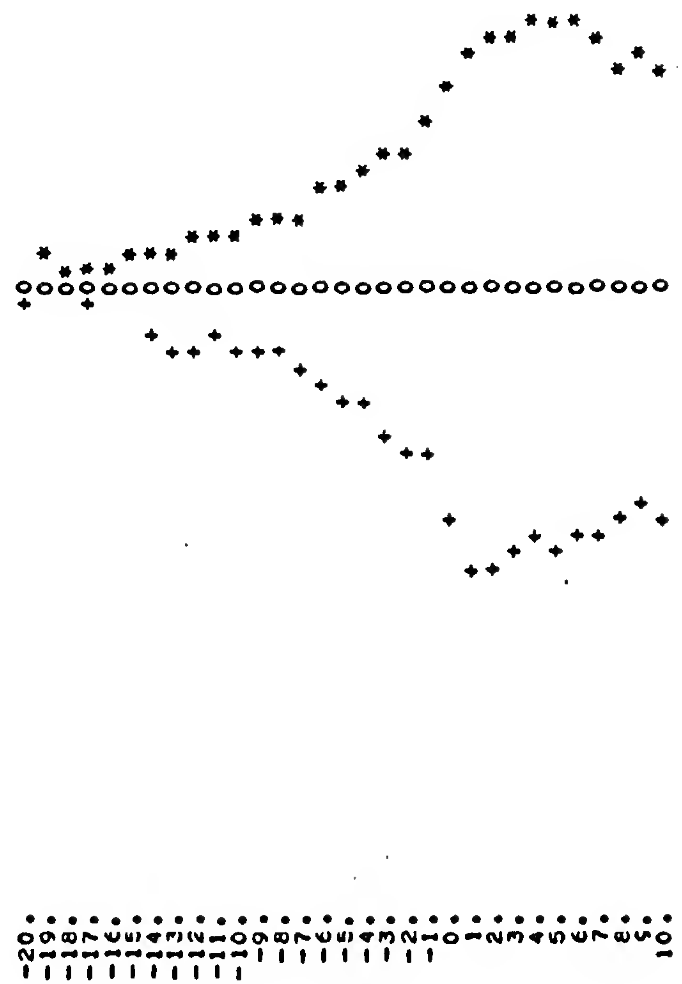


Fig. 7. Pre-earnings announcement movement in the Cumulative Average Residual for Positive and Negative Forecast Error, days -20 to +10.

TABLE 8

PRE-ANNOUNCEMENT AVERAGE RESIDUAL, t STATISTIC, AND CUMULATIVE AVERAGE RESIDUALS FOR POSITIVE FORECAST ERRORS

Day	$\bar{U}$	t of $\bar{U}$	CAR
-20	.00008	.04	.00008
-19	.00091	.03	.00099
-18	.00298	1.29	.00396
-17	.00079	.42	.00495
-16	-.00033	- .13	.00442
-15	.00385	1.80	.00827
-14	-.00097	- .45	.00730
-13	.00261	1.11	.00991
-12	.00252	1.25	.01243
-11	-.00077	- .41	.01165
-10	-.00058	- .30	.01108
- 9	.00341	1.62	.01448
- 8	.00374	1.74	.01822
- 7	-.00077	- .37	.01745
- 6	.00521	1.64	.02266
- 5	.00137	.52	.02404
- 4	.00488	2.11	.02892
- 3	.00252	1.10	.03143
- 2	.00302	1.15	.03445
- 1	.00504	2.03	.03950
0	.01097	3.89	.05047
1	.00517	2.22	.05564
2	.00375	1.52	.05940
3	.00204	1.02	.06143
4	.00312	1.22	.06455
5	-.00125	- .54	.06330
6	.00033	- .10	.06300
7	-.00218	-1.16	.0688
8	-.00359	-1.58	.05720
9	-.00212	-1.01	.05510
10	-.00244	-1.28	.05262

TABLE 9

PRE-ANNOUNCEMENT AVERAGE RESIDUAL, t STATISTIC, AND CUMULATIVE AVERAGE RESIDUALS FOR NEGATIVE FORECAST ERRORS

Day	$\bar{U}$	t of $\bar{U}$	CAR
-20	-.00324	- .90	-.00324
-19	.00309	1.26	-.00015
-18	-.00032	- .08	-.00047
-17	-.00171	- .45	-.00218
-16	.00066	.18	-.00152
-15	-.01255	-3.71	-.01407
-14	.00285	.95	-.01123
-13	-.00356	- .89	-.01478
-12	-.00253	- .03	-.01731
-11	.00317	- .08	-.01414
-10	-.00398	- .96	-.01812
- 9	.00203	.62	-.01609
- 8	.00018	.05	-.01591
- 7	-.00602	-1.67	-.02193
- 6	-.00059	- .17	-.02252
- 5	-.00598	-1.15	-.02850
- 4	.00029	.09	-.02820
- 3	-.00633	-1.69	-.03454
- 2	-.00776	-2.45	-.04230
- 1	.00244	.53	-.03986
0	-.01740	-2.79	-.05727
1	-.00112	-2.15	-.06843
2	.00108	.23	-.06735
3	.00077	.20	-.06658
4	.00457	.92	-.06201
5	-.00147	- .41	-.06348
6	.00346	.50	-.06002
7	-.00142	- .32	-.06144
8	.00539	1.46	-.05605
9	.00288	.96	-.05317
10	-.00306	-1.16	-.05623

is essentially similar for both unexpected increases and unexpected decreases in earnings. It is impossible to determine on the basis of what type of information the market is adjusting the prices of the securities in the sample on the days before the announcement. However, the significant move of the average residual on the days just before the announcement is most probably caused by some group of investors with monopolistic access to information. It is highly unlikely that enough information of an economy- or industry-wide nature arrives in the days just prior to the earnings announcement to cause a statistically significant move in the average residual. Prior to these few days, the movement in the CAR is likely caused by many different sources of information.

Monopolistic access to information would certainly have been profitable in this case. If an investor had invested in the positive series and sold short the negative series twenty days before the earnings announcement, he would have earned a return of almost 6½ percent on the positive series if he sold four days after the earnings announcement. Profit would have been about 6.8 percent on the negative series if held until the day after the announcement. These reates of return are greater than the average 2 percent transactions cost to buy and sell securities in large round-lots. The net return of

4.5 percent for the positive series could have been earned in a twenty-five day period. If one assumes that such investments are continuously available (a heroic assumption), the equivalent annual return is 45 percent. This is merely an academic discussion, however, as it assumes not only monopolistic access to information but also perfect knowledge of how the market will react to such information, an obvious impossibility.

If the securities in the sample had been purchased twenty days prior to publication of the annual number and held until sixty days after, the average return for the positive series would have been 9.7 percent and 12.8 percent for the negative series. Again, this would only accrue to the holder of inside information. In summary, the market appears to have anticipated and adjusted for at least part of the announced earnings prior to the actual announcement date. About 57 percent of the total upward move until day 7 after the earnings announcement takes place prior to the earnings announcement if the cumulative average residual is calculated from day -20. The corresponding number is 56 percent for the negative series.

It is interesting to note from Figure 7 that the CAR begins to trend upward noticeably about fifteen days prior to the earnings announcement. There is no noticeable trend between days -20 and -16. If it is assumed that

there are approximately sixty days (one quarter) between publication of the annual number and publication of the first quarter EPS number, then the fifteen days from 45 to 60 (Figure 6) may correspond to the approximately fifteen days the market is anticipating the EPS number. Of course, first quarter EPS are as likely to increase as decrease so that the CAR appears to move randomly from days 45 to 60.

Figure 7 clearly illustrates the differences in the adjustment process for the second stage between positive and negative forecast errors. The negative series is more random and flatter in the second stage after publication. Because the anticipation process is essentially similar for both series, the differences in the market reaction to the publication of the EPS number and not because of differences in the anticipation process.

CHAPTER IV

SUMMARY AND CONCLUSIONS

Major Results

The most important results of this paper are its findings with respect to market efficiency. The excess return from purchasing the securities in the sample at the time of the publication of the EPS number is substantially in excess of transactions costs, and the adjustment process takes a considerable length of time (about forty-five days). This cannot be considered to be an "instantaneous adjustment." Thus, by the two major criterion of efficiency for publicly available information, the market appears to exhibit inefficiencies.

Secondary results indicate that the adjustment process of the stock market to new EPS information may follow a fairly standard pattern as a result of the way information reaches investors. Specificially, the lag between the publication of the annual number in The Wall Street Journal and the subsequent receipt of the annual report by shareholders and analysts may cause the market to initially react to the publication of the annual number and then to react to the annual report with permanent price changes. Comparison of the adjustment of stock

prices for positive and negative forecast errors suggests that the adjustment mechanism is quite similar, although in opposite direction, for unexpected earnings increases and unexpected earnings decreases.

Examination of preannouncement movements in security prices indicate that the publication of the annual EPS number does not take the market completely by surprise. The market was able to anticipate the direction of change in EPS and to adjust security prices accordingly although it was impossible to determine the type of information used in this anticipation process.

Limitations of the Study

It is significant to remember that the results presented and the conclusions drawn in this paper are with respect to the specific securities in the sample. The sample is subject to a strong pre-selection bias in the time period examined of the securities in the sample; i.e., each firm's earnings in the selected time period fit the fairly narrow criteria of the selection process. Thus, each security in the sample has the following:

1. At least a 20 percent change in annual EPS.
2. Fourth quarter earnings different from that which could have been predicted on the basis of the first three quarters of results.
3. Its annual EPS number published in The Wall Street Journal between February 15 and March 20 in one of the years from 1963 to 1971.

4. Its common stock listed on either the New York or American Stock Exchange and its price and volume data on Standard & Poor's ISL Tapes for the period in question.

5. No extraordinary earnings in its annual EPS number.

Thus, the conclusions drawn may be general and representative only of firms which meet the above criteria.[1] The most important of the above criteria from the viewpoint of the conclusions drawn in this study are probably the first two. First, the initial two stages of the adjustment process may be attenuated or non-existent for securities whose annual EPS change by less than 20 percent (that is true if the analysis of the causes of the different stages of the adjustment process is correct). Second, the abnormal return earned by the securities in this study is probably attenuated for securities with smaller forecast errors; i.e., there is little expected price change resulting from the purchase of securities whose EPS number, on average, closely approximates what the market expects.

The results and conclusions of this study are with respect to market reactions to annual EPS numbers. Nothing has been said about market reactions to quarterly EPS

---

[1]The companies in the sample should be fairly representative of all listed securities as the estimated average beta coefficient was sufficiently near to one to indicate that the securities in the sample were about as risky, on average, as the market portfolio.

numbers other than fourth quarter EPS as they reflect on the annual number in the rather narrow earnings model criterion of the paper. There is growing evidence that the market does use interim reports in stock price formation (see Brown and Kennelly [9] and Kiger [22]).

Some Implications of the Study

The results of the study cast some doubts on the validity of the Efficient Markets Hypothesis in its semi-strong form. It was found that the prices of the securities in the sample had not "fully reflected" all publicly available information. It took some time (about forty-five days) for the market to adjust, and it appears as though a rate of return in excess of the transactions costs necessary to purchase the securities could have been earned with a high level of confidence by using publicly available information.

One practical implication of this study is concerned with company policy of having annual EPS numbers published in The Wall Street Journal prior to making the annual report available to shareholders and analysts. If publication of the annual number in the news media causes the price of the firm's securities to react to incomplete information, and thus subjects investors to greater variation in return (even if only for a few days), then the company should consider witholding publication of

EPS numbers until after the mailing of the annual report.

Proponents of the Efficient Markets Hypothesis believe that it is very difficult to earn an excess rate of return through the use of fundamental information. Contrary to this belief, it appears as though fundamental analysis might have been of some value in earning an abnormal rate of return using publicly available information; the optimal strategy would have been to use some sort of earnings model such as the QFE model in this paper, and purchase those securities which met the model screening criterion. This is a form of fundamental analysis.

Another implication of these findings concerns the value of accounting information. Some proponents of the Efficient Markets Hypothesis have gone so far as to assert that accounting information is of little value, as there are enough competing sources of information (e.g., industry- and economy-wide movements) to allow the market to come up with an unbiased guess of the true economic worth of a firm without actually seeing an accounting statement. This study has found that accounting information had some definite impact on security prices and thus had some value as information.

The results of this study suggest that stock prices may follow a fairly set pattern in adjusting to

changes in EPS. The fact that there are non-random patterns of stock price changes which may repeat from one security to the next when an unexpected change in EPS occurs could mean that technical or chartist theories have some underlying validity. Chartists maintain that linear statistical techniques used to measure price dependencies in stock returns are not sufficiently sophisticated to identify the complicated patterns which they see. They further feel that charting techniques allow them to earn an abnormal return by identifying the actions of insiders using monopolistic sources of information before it becomes available to the general public. Although this study identifies some non-randomness in the market it has yet to be established that chartists can use such non-randomness to earn an abnormal return. Indeed, the simple patterns of adjustment observed in this study do not seem complex enough to justify an involved chartist theory. Further research on charting should concentrate on plotting return residuals from the market model rather than price data because the market model allows the researcher to abstract from general market movements which are random in nature.

Perhaps the most important implication of this study concerns the Capital Asset Pricing Model (CAPM). One of the basic assumptions of the CAPM is that the

market is efficient; i.e., all investors are price takers. The findings of this study suggest that this is not so, at least for some securities in some time periods. This finding casts some doubt on the validity of the CAPM as a general model of the stock return generating process.

One potentially fruitful area of further research is the issue of beta stability. Recall that this study found a statistically significant shift in the average level of systematic risk of the securities in the sample between two time periods separated by only about six months. This shift occurred in a portfolio of 158 securities. During one of these time periods there is strong reason to believe that the market was adjusting to some change in EPS. This suggests that some of the observed instability of beta in other studies may have been caused by a lack of market efficiency.

The mis-specification of the CAPM due to market inefficiencies during certain time periods may not seriously affect the conclusions of the CAPM, as the parameters in the CAPM are typically estimated using a monthly differencing interval and using several years of observations. Since EPS typically vary randomly, the effects of market inefficiencies are likely to cancel over a period of months or years. Just how much market inefficiencies identified in this study will change the conclusions of the CAPM should be the topic of further research.

BIBLIOGRAPHY

1. Ball, Ray. "Risk, Return, and Disequilibrium: An Application to Changes in Accounting Techniques," Journal of Finance 27 (May 1972): 343-53.

2. ________, and Brown, Philip. "Some Preliminary Findings on the Association Between the Earnings of a Firm, Its Industry and the Economy," Empirical Research in Accounting: Selected Studies, Supplement to Volume 5 of the Journal of Accounting Research (1967): 55-57.

3. ________, and ________. "An Empirical Evaluation of Accounting Income Numbers," Journal of Accounting Research (Autumn 1968):159-78.

4. Black, Fischer. "Capital Market Equilibrium with Restricted Borrowing," Journal of Business 45 (July 1972):444-55.

5. ________; Jensen, Michael C.; and Scholes, Myron. "The Capital Asset Pricing Model: Some Empirical Tests." In Studies in the Theory of Capital Markets. Edited by Michael C. Jensen. New York: Praeger Press, 1972.

6. Blattberg, Robert C., and Gonedes, Nicolas. "A Comparison of the Stable and Student Distribution as Statistical Models for Stock Prices," Journal of Business 47 (April 1974):244-80.

7. Blume, Marshall E., and Friend, Irwin. "A New Look at the Capital Asset Pricing Model," Journal of Finance 27 (March 1973):19-32.

8. Brealey, Richard A. An Introduction to Risk and Return from Common Stock. Cambridge: The M.I.T. Press, 1969.

9. Brown, Phillip, and Kennelly, John. "The Information Content of Quarterly Earnings: An Extension and Some Further Evidence," Journal of Business 45 (July 1972):403-15.

10. Cochrane, D., and Orcutt, G. H. "Application of Least Squares Regressions to Relationships Containing Auto Correlated Error Terms," Journal of the American Statistical Association 44 (March 1949):749-809.

11. Cootner, Paul, ed. The Random Character of Stock Market Prices. Cambridge: The M.I.T. Press, 1964.

12. Downes, David, and Dyckman, Thomas. "A Critical Look at the Efficient Market Empirical Research Literature as It Relates to Accounting Information," The Accounting Review 47 (April 1973): 300-22.

13. Fama, Eugene. "The Behavior of Stock Market Prices," Journal of Business 37 (January 1965):34-105.

14. ________. "Efficient Capital Markets: A Review of Theory and Empirical Work," Journal of Finance 25 (May 1970):383-417.

15. ________; Fisher, Lawrence; Jensen, Michael C.; and Roll, Richard. "The Adjustment of Stock Prices to New Information," International Economic Review 10 (February 1969):1-26.

16. ________, and MacBeth, James. "Risk, Return, and Equilibrium; Empirical Tests," Journal of Political Economy 81 (May-June 1973):607-36.

17. Fisher, Lawrence, and Lorie, James H. "Rates of Return on Investments in Common Stock: the Year-by-Year Record, 1926-65," Journal of Business 41 (July 1968):291-316.

18. Jaffe, Jeffrey F. "Special Information and Insider Trading," Journal of Business 27 (July 1974): 410-18.

19. Jensen, Michael C. "The Performance of Mutual Funds in the Period 1945-1964," Journal of Finance 23 (May 1968):389-416.

20. Jones, Charles P., and Litzenberger, Robert H. "Quarterly Earnings Reports and Intermediate Stock Price Trends," Journal of Finance 25 (March 1970):143-48.

21. Kaplan, Robert A., and Roll, Richard. "Investor Evaluation of Accounting Information: Some Empirical Evidence," Journal of Business 45 (April 1970):225-57.

22. Kiger, Jack E. "An Empirical Investigation of NYSE Volume and Price Reactions to the Announcement of Quarterly Earnings," Empirical Research in Accounting: Selected Studies, Supplement to Volume 10 of the Journal of Accounting Research (1972):113-27.

23. Lintner, John. "The Evaluation of Risk Assets and the Selection of Risky Investments in Stock Portfolios and Capital Budgets," Review of Economics and Statistics 47 (February 1965): 13-37.

24. ________, and Glauber, Robert. "Higgledy Piggledy Growth in America." In Modern Developments in Investment Management. Edited by J. Lorie and R. Brealey. New York: Praeger Publishers, 1972.

25. Malkial, Burton G. "Equity Yields, Growth, and the Structure of Share Prices," American Economic Review 53 (December 1963):1005-1103.

26. Mandelbrot, Benoit. "Forecasts of Future Prices, Unbiased Markets, and Martingale Models," Journal of Business, Special Supplement 39 (January 1966):242-55.

27. Miller, Merton H., and Modigliani, Franco. "Dividend Policy, Growth and the Valuation of Shares," Journal of Business 34 (October 1961):411-33.

28. Mossin, Jan. "Equilibrium in a Capital Asset Market," Econometrica 34 (October 1966):768-83.

29. Niederhoffer, Victor, and Osboirne, M. F. M. "Market Making and Reversal on the Stock Exchange," Journal of the American Statistical Association 59 (December 1966):897-916.

30. ________, and Regan, P. J. "Earnings Changes Analysts' Forecasts, and Stock Prices," Financial Analysts Journal 28 (May-June 1971): 65-71.

31. Officer, Robert R. "Time Series Examination of the Risks Implies by the Market Model." In Fama, Eugene. "Efficient Capita Markets: A Review of Theory and Empirical Work," Journal of Finance 25 (May 1970):383-417.

32. Sharpe, W. "Capital Asset Pricing: A Theory of Market Equilibrium Under Conditions of Risk," Journal of Finance 19 (September 1964): 425-42.

33. ________. "Comment on Efficient Capital Markets: A Review of Theory and Empirical Work," Journal of Finance 25 (May 1970):383-417.

BIOGRAPHICAL SKETCH

Stewart Brown was born in Spencerport, New York, in May, 1943. He graduated from Spencerport High School in 1961 and served in The United States Navy from August, 1963, to June, 1967. He then attended Daytona Beach Community College until December, 1968, when he transferred to the University of Florida. He is currently Assistant Professor of Finance at the Florida State University.

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

Fred D. Arditti

Fred D. Arditti, Chairman
Professor of Finance

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

John B. McFerrin

John B. McFerrin
Professor of Finance

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

William A. McCollough
Assistant Professor of Finance

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

Christopher B. Barry

Christopher B. Barry
Assistant Professor of Management

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

James T. McClave
Assistant Professor of Statistics

This dissertation was submitted to the Graduate Faculty of the Department of Finance in the College of Business Administration and to the Graduate Council, and was accepted as partial fulfillment of the requirements for the degree of Doctor of Philosophy.

December, 1974

Harry H. Sisler, Dean
Graduate School